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# ***JPRS Report***

# **Science & Technology**

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***USSR: Physics &  
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# Science & Technology

## USSR: Physics & Mathematics

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12 FEBRUARY 1988

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**Additional Peak of Light Scattering by Sound  
Under Conditions of Acoustic Instability**

18620187c Leningrad FIZIKA TVERDOGO TELA in  
Russian Vol 29, No 4, Apr 87 pp 1199-1202

[Article by V.d. Kagan, Institute of Engineering Physics  
imeni A.F. Ioffe, USSR Academy of Sciences, Lenin-  
grad; manuscript received 3 Nov 86]

[Abstract] A mathematical model is constructed for explaining the appearance of an additional peak of light scattering by sound when the latter fluctuates under conditions of instability. The underlying theory stipulates formation of another diffraction grating in addition to the ordinary Mandelshtam-Brillouin grating and associates the additional scattering peak with diffraction by this new grating so that the laws of wave vector and frequency conservation are circumvented. A phonon distribution and a wave vector distribution are considered which have not only a smooth part but also a sharp peak at some value of the wave vector. The theory is proved on this basis by first assuming that both distributions are not functions of the space coordinates, as may be the case in a highly turbulent medium, and then recognizing that both distributions grow to saturation as they vary in space. The gist of the proof lies in calculation of the differential extinction coefficient according to Landau-Lifshits for scattering of plane waves. The author thanks Yu.M. Galperin, A.M. Dyakonov, and R.V. Katilyus for discussion. References 5: all Russian.

02415/06662

**Effect of Mg Impurity on Local Vibrations of  
U-Centers in LiF Lattice**

18620181a Leningrad FIZIKA TVERDOGO TELA in  
Russian Vol 29, No 4, May 87 pp 1525-1526

[Article by L.I. Bryukvina and V.M. Khulugurov, Scien-  
tific Research Institute of Applied Physics, Irkutsk Uni-  
versity imeni A.A. Zhdanov; manuscript received 22 Oct  
86]

[Abstract] An experimental study of LiF crystals with OH<sup>-</sup> ions perturbed by an Mg impurity was made which revealed additional lines along the quiescent U-center line in their infrared absorption spectrum. The crystals had been grown by the Kiropulos method with MgF<sub>2</sub> added during the process. Their spectrum was measured in a "Ur-20" spectrophotometer at room temperature. Here the 3730 cm<sup>-1</sup> absorption band of quiescent OH<sup>-</sup> ions was missing, but the Mg<sup>++</sup>OH<sup>-</sup>-complex was found to have produced a strong 3575 cm<sup>-1</sup> line as well as weak 3545 cm<sup>-1</sup> and 3630 cm<sup>-1</sup> peaks. The crystals were then exposed to gamma-radiation from a <sup>60</sup>Co source. A dose of 10<sup>18</sup>R weakened those three absorption lines while producing wide absorption bands within the 180-3500 cm<sup>-1</sup> range and exciting U-centers at a frequency of 1015 cm<sup>-1</sup>. Subsequent annealing with the temperature raised in 50SDC steps up to 350SDC intensified absorption within that band, annealing at temperatures from 150SDC up also producing additional absorption peaks. Figures 1; references 4: 1 Russian, 3 Western) [in Russian translation].

02415/06662

**New Method of Examining Micrononhomogeneity of Local Centers in High-resistivity Semiconductor Materials Under Scanning Electron Microscope**

18620199 Leningrad PISMA V ZHURNAL FIZIKI in Russian Vol 13, No 7, 12 Apr 87 pp 385-388

[Article by A.V. Govorkov, E.M. Omelyanosvskiy, A.Ya. Polyakov, V.I. Raykhshteyn, and V.A. Fridman; manuscript received 28 Oct 86]

[Abstract] Photoelectric relaxation spectroscopy of high-resistivity semiconductors, photocurrent relaxation in a structure with a Schottky barrier and constant reverse bias being recorded after that structure has been excited by a radiation pulse, can be used for examining the micrononhomogeneity of local centers in such semiconductors under a scanning electron microscope. This application was demonstrated on GaAs chips with In impurity such as for LSI technology. On the relaxation curve the initial fast current decrease, owing to recombination and leakage of excess charge carriers, is followed by a long "tail" representing a thermal mechanism by which carriers trapped in the space-charge region jump into an allowed band. In the experiment for the first time an electron beam was used for excitation of GaAs:In structures, reverse bias of the Schottky barrier being provided through a current amplifier. The photocurrent relaxation transient after the end of an excitation pulse was recorded with the aid of an electronic probe at various temperatures, typically at 85 K and 240 K. The readings were processed by a computer with an automatic graph plotter for the construction of spectra with different "time windows" and peak intensities at different temperatures corresponding to different concentrations and energy levels of deep centers. Figures 2; references 3: 1 Russian, 2 Western.

02415/06662

**Dispersion of Kerr Effect in Isotropic Phase of 4-n-AMYL-4'-Hexoxy-ga-Cyanostilbene Liquid Crystal**

18620192a Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 4, Apr 87 pp 784-788

[Article by M.A. Agafonov, S.G. Polushin, and Ye.I. Ryumtsev; manuscript received 13 Jun 86]

[Abstract] The electrooptic birefringence Kerr effect in the isotropic phase of a liquid crystal is evaluated, 4-n-amy-4'-hexoxy-ga-cyanostilbene being such a crystal with a  $T_c = 47.2$ SDC temperature of transition from isotropic liquid to nematic crystal and a  $g_m = 3.8$  D dipole moment oriented at a  $g_b = 64$ SD angle to the longitudinal axis of its molecule. Measurements were made by two methods, each yielding data on both molecular and supermolecular relaxation processes. One method involved recording the time-invariant component of luminous flux, after passage through a "polarizer—Kerr cell—analyzer" system, at various frequencies of the electric field. The other method involved

recording the time-invariant component of birefringence as inverse functions of frequency, confirming accordingly negligible dispersion associated with the dipole mechanism of polarization within the  $F = 10^3$ - $10^7$  Hz radio-frequency range. Further calculations based on thermal measurements and analysis taking into account viscosity yield  $L = 3.1 \cdot 10^7$  erg/cm<sup>3</sup> for the latent heat of phase transition from nematic crystal to isotropic liquid. The authors thank I.V. Sochav and G.I. Tsereteli for measuring the heat of phase transition in this o-cyanostilbene. Figures 4; references 11: 8 Russian, 3 Western (1 in Russian translation).

02415/06662

**Quasi-local States in Conduction Band Excited by Indium Ions in Crystals of Alkali Halides**

18620187a Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, Apr 87 pp 1011-1016

[Article by L.Ye. Nagli and N.G. Stanko, Institute of Physics, LaSSR Academy of Sciences, Slaspils; manuscript received 22 May 86, in final version 15 Aug 86]

[Abstract] An experimental study of radiation absorption induced in KCl, KBr, KI crystals by In<sup>+</sup> ions was made, KCl:In<sup>+</sup>, KBr:In<sup>+</sup>, KI:In<sup>+</sup> crystals having minima of tetragonal symmetry and trigonal symmetry in the lower relaxed excited state. Measurements were made by the method of 2-stage spectroscopy on crystals in a helium cryostat, either A-band absorption or C-band absorption being vigorously excited with radiation from an XeCl excimer laser ( $\lambda = 306$  nm wavelength) or a KrF excimer laser ( $\lambda = 249$  nm wavelength). The crystals were probed with light pulses of 60 ns duration from a DKSSh-500 xenon flashtube, spectra and kinetics being recorded on a S8-12 oscillograph with the aid of an FEU-97 photomultiplier and an MDR-3 monochromator. These measurements have yielded the temperature-dependent kinetic of luminescence decay and absorption excitation over the 4.2-300 K temperature range, only over the 150-300 K temperature range in the KCl:In<sup>+</sup> crystal excited by the XeCl-laser, as well as the energy-dependent spectra of excited absorption all these crystals over the 2.5-5.5 eV energy range. Evaluation of the data on the basis of known mechanisms in the single-oscillator approximation indicates that doping such crystals with In<sup>+</sup> ions gives rise to quasi-local states in the conduction band, excited absorption being a consequence of transitions to these states from the triplet relaxed excited state. Figures 5; table 1; references 15: 6 Russian, 9 Western (2 in Russian translation).

02415/06662

**Characteristics of Short-wave Luminescence in BaF<sub>2</sub> Crystals**

18620192f Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 4, Apr 87 pp 943-945

[Article by P.A. Rodnyy and V.A. Gussar; manuscript received 24 Oct 86]

[Abstract] The mechanism of short-wave luminescence in  $\text{BaF}_2$  crystals is analyzed in light of new experimental data on x-ray luminescence in  $\text{BaF}_2$  as well as  $\text{SrF}_2$  and  $\text{CaF}_2$  crystals. Experiments were performed on 2 mm thick  $10 \times 10 \text{ mm}^2$  large wafers with an RTI 2-0.05 x-ray flashtube or radioactive isotopes such as  $^{55}\text{Fe}$  (5.6 keV) and  $^{241}\text{Am}$  (59.6 keV) as excitation source. The intensity of the 220 nm band was highest in pure crystals and almost the same or lower in crystals with Mn, Nd, Eu, Dy, Pb impurities. The main characteristics of this luminescence within the 220 nm band were found to be constant intensity during heating of crystals from room temperature up to 850 K, a decay time shorter than 1 ns, and a slight shift of singlet excitons to longer waves than those of triplet excitons in  $\text{CaF}_2$  and  $\text{SrF}_2$  but not  $\text{BaF}_2$  crystals. The results indicate a peculiar form of fundamental optical fluorescence in  $\text{BaF}_2$  crystals, by a non-exciton mechanism, its spectral and intensity characteristics not being compatible with hot exciton luminescence. References 13: 9 Russian, 4 Western.

02415/06662

**Infrared Reflection-Absorption Spectroscopy of Hyperfine Layers on Surfaces of Semiconductors and Dielectrics**

18620196c Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 46, No 5, May 87 pp 775-780

[Article by S.N. Gruzinov and V.P. Tolstoy; manuscript received 23 Jan 86]

[Abstract] Infrared reflection-absorption spectroscopy of film on surfaces of transparent or weakly absorbing semiconductor and dielectric substrates is analyzed theoretically, the purpose being to establish the conditions for maximum sensitivity of this method. The "absorption factor," namely the relative change of the reflection coefficient upon formation of a film on the substrate surface  $gDR/R_0$  ( $R_0$  - reflection coefficient of bare substrate,  $gDR = R - R_0$ ,  $R$  - reflection coefficient of coated substrate is selected as the sensitivity criterion. The analysis is based on exact relations, one for a homogeneous isotropic absorbing film between substrate and ambient medium with plane-parallel boundaries and one for a reflecting layer with the possibility of multiple reflections taken into account. Calculations have been programmed on a computer for up to 60 nm thick  $\text{SiO}_2$  films on various substrates and infrared radiation within the 8-11  $\mu\text{m}$  waveband. The results indicate that the dependence of the "absorption factor" on the radiation wavelength and on the film thickness is different with the radiation s-polarized than with the radiation p-polarized. Calculations have also yielded the dispersion of optical constants characterizing a  $\text{SiO}_2$  film. According to these results, infrared spectroscopy is most sensitive to films on substrates with a small refractive index and when done with p-polarized radiation incident at

exactly or approximately the Brewster angle for a determination of their presence and their composition respectively, also when no multiple reflections occur. Figures 4; references 7: 6 Russian, 1 Western.

02415/06662

**Radiation Emission by Color Centers in  $\text{Al}_2\text{O}_3$ :Mg Crystal**

18620186c Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 914-915

[Article by B.b. Boyko, A.P. Shkadarevich, E.a. Zhdanov, I.I. Kalosha, V.G. Koptev, and A.a. Demidovich; manuscript received 14 Oct 87]

[Abstract] In an experiment with  $\text{Al}_2\text{O}_3$  crystals grown by the Verneuil method and containing  $10^{-5}$ - $10^{-2}$

Mg emission of radiation was discovered within the 500-590 nm range of wavelengths, after a special heat treatment resulting in formation of active color centers and turning such crystals greenish. A crystal was placed inside a nonselective resonator cavity, between two plane mirrors with 99.8% reflectance and 50% reflectance respectively at the 520 nm wavelength, and longitudinally pumped by a dye laser (coumarin 120,  $\lambda = 440 \text{ nm}$  wavelength) in pulses of 20 ns duration. This laser was, in turn, pumped by a Lambda Physics EMG-120 excimer laser ( $\text{XeCl}$ ,  $\lambda = 308 \text{ nm}$  wavelength). Absorption spectra were recorded with a Beckman UV 5270 spectrophotometer, luminescence spectra and luminescence excitation spectra were recorded with a Fica 55 spectrofluorimeter, with a "PRA-300" nanosecond fluorimeter recording the luminescence kinetics, emission spectra were recorded with an STE-1 spectrograph, and the energy characteristics were measured with an RJ 7200 calorimeter using pyroelectric transducers. Pumping radiation was focused on an activated crystal 8 mm in diameter and 20 mm long through a spherical lens with 200 mm focal length. The emission threshold was 25  $\text{MW/cm}^2$  and the maximum efficiency was only 5, owing to the presence of parasitic color centers and high scattering losses. This discovery indicates that lasing by an  $\text{Al}_2\text{O}_3$  crystal is attainable without neutron bombardment. Figures 2; references 6: 2 Russian, 4 Western.

02415/06662

**Bloch Oscillations in Small Josephson Junctions: Their Manifestation in Switching Effects**

18620181b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, May 87 pp 1580-1582

[Article by R.O. Starobogatov and G.Yu. Yashin, Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences, Leningrad; manuscript received 1 Dec 86]

[Abstract] Switching-on the current through a small Josephson junction, a current larger than critical  $I_0 = -g\phi D/eR_T$  ( $gD$  - lower tunneling band,  $e$  - electron



charge,  $R_T$  - dynamic junction resistance), is analyzed and the transient current-voltage characteristic is shown to have not only a drooping range with oscillations near current resonance but also a voltage harmonic of the same frequency immediately after time  $t = 0$ . This "bell" effect is demonstrated theoretically by describing the state of such a junction according to the one-band model with an analog of the conditional-probability distribution function, such as that in the Volterra equation, which satisfies with Fokker-Planck equation. This equation is solved exactly for the simple case of a lower tunneling band much narrower than the energy gap and with steady state as the initial condition. The voltage harmonic is then calculated with the aid of Josephson's second law. References 6: 3 Russian, 2 Western.

02415/06662

**Electron-paramagnetic Resonance of  $\text{Er}^{3+}$  Centers in Y-Al Garnet**

18620187f Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, Apr 87 pp 1261-1264

[Article by P.F. Baranov, V.I. Zhekov, T.M. Murina, A.M. Prokhorov, and V.a. Khramtsov, Institute of Engineering Physics imeni A.F. Ioffe, USSR Academy of Sciences, Leningrad; manuscript received 3 Nov 86]

[Abstract] In an experimental study of Y-Al:Er<sup>3+</sup> garnets were discovered new paramagnetic Er<sup>3+</sup>-centers with characteristics very different than those of earlier

reported ones (M. Bail, G. Garton, M.J.M. Leask, D. Ryan, W.P. Wolf, JOURNAL OF APPLIED PHYSICS Vol 32, Suppl. No 3, 1961) but appearing in comparable concentrations. Spectra of their electron-paramagnetic resonance in Y<sub>3</sub>AlO<sub>12</sub>+ (0.05, 0.3, 3, 15, 50)Er crystals were recorded at temperatures ranging from 56 K (0.05Er) to 25 K (50

Er), with each crystal variously oriented relative to the magnetic field by rotation about its [100] axis while this axis was first perpendicular and then parallel to the magnetic field. There were detected two EPR lines with H[100] attributable to the new kind of Er<sup>3+</sup>-centers and shifting in each case upon rotation of the crystal. Signals form uncontrollable Mo<sup>3+</sup>, Nd<sup>3+</sup>, Yb<sup>3+</sup> impurity centers were also recorded among these spectra. There thus exist two kinds of Er<sup>3+</sup>-centers in Y-Al garnet crystals, the symmetry of both corresponding to c-positions of Y<sup>3+</sup> ions they replace. The new centers have a larger anisotropy with gg1, while the other kind has gThe hyperfine-interaction constant has been calculated on a preliminary basis for various orientation of the magnetic field relative to the axis of a <sup>167</sup>Er<sup>3+</sup>-center. The authors thank Kh.S. Bagdasarov for supplying some of the crystals and for discussions, also A.G. Badalyan for discussion of the results. Figures 2; references 5: 1 Russian, 4 Western.

02415/06662



**Radiation Absorption in Neodymium Glasses  
During Passage of Strong Laser Pulse**

18620183a Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 45, No 9, 10 May 87 pp 410-412

[Article by V.V. Ivanov, Yu.V. Senatskiy, and G.V. Sklizkov, Institute of Physics imeni P.M. Lebedev, USSR Academy of Sciences; manuscript received 23 Mar 87]

[Abstract] Selective radiation absorption in neodymium glasses was recorded experimentally during passage of a laser pulse of 0.5-0.7 ns duration with 2-5 J/cm<sup>2</sup> energy density coming from a YAG:Nd<sup>3+</sup> laser oscillator ( $\lambda_1 = 1.064$  gmm wavelength) with periodic Q-switching, after amplification by two YAG:Nd<sup>3+</sup> stages and one GLS-9P glass stage with subsequent spatial filtration by a relay. A weak probing pulse synchronized and aligned with the strong pumping pulse was generated by an auxiliary oscillator with YAG:Nd<sup>3+</sup> crystals and KNPS glass. This probing pulse revealed absorption of radiation in rods of phosphate glasses and of silicate glasses containing Nd<sup>3+</sup> activator ions. From the changes in both intensity and profile of a probing pulse after two passage through a glass rod 2 mm in diameter selective absorption of radiation at three wave lengths within the transparency window of neodymium glasses was determined:  $\lambda_1 = 0.66$  gmm (pulse duration about 70 ns),  $\lambda_2 = 1.053$  gmm (pulse duration about 130 ns),  $\lambda_3 = 0.56$  gmm (pulse duration about 10 ns). An absorption jump was recorded at the  $\lambda_1 = 0.66$  gmm radiation wavelength. Induced absorption was found to being in phosphate glasses at a power density of 3.6 GW/cm<sup>2</sup> and in silicate glasses at a power density of 5.2 GW/cm<sup>2</sup>. Selective absorption of 0.66 gmm and 1.053 gmm radiation can be associated with transition in the Nd<sup>3+</sup> ion as a result of nonlinear processes in the glass, induced absorption being attributable to small-scale self-focusing.

The authors thank N.Ye. Bykovskiy for assistance, V.F. Surkov for supplying specimens of neodymium glasses, Yu.K. Danilevko and A.Ya. Karasik for helpful discussions. Figures 3; reference 2: 1 Russian, 1 Western.

02415/06662

**Nonlinearly Tunable Wideband Emission of  
Infrared Radiation by Al<sub>2</sub>O<sub>3</sub>:Ti Laser**

18620192d Leningrad OPTIKA I SPEKTROSKOPIYA  
in Russian Vol 62, No 4, Apr 87 pp 891-893

[Article by D.V. Bakin, L.M. Dorozhkin, Yu.I. Krasilov, N.T. Kuznetsov, and A.V. Shestakov; manuscript received 23 Jun 86]

[Abstract] A tunable coherent source of infrared radiation can be produced by use of an Al<sub>2</sub>O<sub>3</sub>:Ti crystal as laser-converted ( $\lambda_3 = 0.66$ -0.98 gmm wavelengths) and pumping it with second-harmonic radiation ( $\lambda_2 = 0.532$  gmm wavelength) from a YAG:Nd laser ( $\lambda_1 = 1.064$

gmm wavelength), the efficiency of such a source exceeding 40 percent. A study was made on this premise pertaining to the feasibility of a coherent radiation source tunable over the 1.2-12 gmm range of wavelengths based on the  $gq_2$ - $gq_3$  or  $gq_3$  -  $gq_1$  difference-frequency generating mechanism. The results have revealed that  $gq_2$ - $gq_3$  difference-frequency radiation is most efficiently generated by  $eo=0$  interaction in a LiNbO<sub>3</sub> or Ba<sub>2</sub>NaNb<sub>5</sub>O<sub>15</sub> mixer crystal, with possible control of noncritical phase synchronism by temperature regulation. The experiment used a 20 mm long LiNbO<sub>3</sub> crystal cut at the angle of non-critical phase synchronism, only  $eo=0$  interaction with  $g_2$ -wave as the e-wave being possible in such a crystal, and a YAG:Nd laser with Q-switching at a frequency of 1 Hz. The Al<sub>2</sub>O<sub>3</sub>:Ti crystal, 10 mm long and 5x5 mm<sup>2</sup> in cross-section, was placed inside a 13 mm long plane-parallel cavity. The pumping second-harmonic radiation in pulses of 15 ns duration with maximum energy of 40 mJ was focused by a 320 mm long lens on the interior of this Al<sub>2</sub>O<sub>3</sub>:Ti crystal, which then absorbed 80 percent of that radiation. The emission wavelength of this laser was varied over the 0.7-0.9 gmm range by selection of mirrors, the reflection coefficient of the exit mirror varying from  $R = 0.6$  for  $g_3 = 0.8$  gmm radiation to  $R = 0.95$  for  $g_3 = 0.7$  gmm radiation and  $g_3 = 0.9$  gmm radiation and the reflection coefficient of the other mirror varying from  $R = 0.998$  for  $g_3 = 0.7$ -0.9 gmm radiation to  $R = 0.10$  for  $g_2 = 0.532$  gmm radiation. At the  $g_3 = 0.8$  gmm optimum emission wavelength the emission line was 20 nm wide and the efficiency of the Al<sub>2</sub>O<sub>3</sub>:Ti laser reached 12 percent, with a 20 ns delay from pump pulse peak to emission pulse peak. This delay could be shortened by raising the pump pulse energy from the 6 mJ near-threshold level to 30 mJ, which shortened the emission pulse duration from 4 ns to 3 ns. In accordance with the experimentally determined dependence of the temperature of noncritical phase synchronism on the  $g_3$  emission wavelength, consistent and nearly coinciding with the theoretical dependence based on the  $n(g,\lambda)$  dispersion of the refractive index, it was possible to tune the difference-frequency radiation over the  $\lambda_4 = g_2 g_3 / g_1$  -  $g_2 = 1.3$ -2.2 gmm range by temperature regulation over the 20SDC width of phase synchronism. Figures 2; references 9: 4 Russian, 5 Western.

02415/06662

**Time Characteristics of Ultrashort Light Pulses  
From Dye Lasers With Distributed Feedback**

18620186a Moscow KVANTOVAYA ELEKTRONIKA  
in Russian Vol 14, No 5, May 87 pp 906-909

[Article by A.N. Rubinov, B.A. Bushuk, and A.L. Berestov, Institute of Physics, BSSR Academy of Sciences; manuscript received 19 Sep 86]

[Abstract] An experimental study of distributed-feedback dye lasers excited by picosecond pulses from a solid-state laser was made, for the purpose of determining the time characteristics of their ultrashort emission

pulses. Two dye lasers were tested, one with ethanol solution of rhodamine 6G and one with ethanol solution of oxazine 17 as active medium. YAG:Nd<sup>3+</sup> laser set consisting of a master oscillator with passive mode locking was used as the pump together with a monopulse extractor, and two amplifier stages. Radiation from the pump laser was passed through a KDP crystal for frequency conversion into second-harmonic pulses of 5 mJ energy and 30 ps duration. From these pulses a glass plate diverted a small reference signal which, after passage through a total-reflection prism acting as a delay line, was split by a quartz module into two parts appearing 76 ps apart on the screen of an AGAT SF electron-optical instrument. The large remainder pumped the dye laser, after passage through another delay line, a filter, a cylindrical telescope, and then being split into two beams of equal intensities for interference in the dye solution facilitated by means of two plane guide mirrors and a 90SDC prism. Emission pulses from the dye laser were guided by mirrors into the chamber of that AGAT SF instrument, where FD-24K photodiodes calibrated against an RJ 7200 calorimeter recorded their energy as well as that of second-harmonic pump radiation pulses.

Measurements were made which yielded the dependence of the time delay from pump pulse to emission pulse and of the emission pulse duration on the wavelength of emission pulses at a pump energy level up to 300

above the threshold, with the rhodamine laser tunable over the 560-585 nm range by regulation of the angle between the two interfering half-beams. Measured was also the dependence of that time delay on the ratio of pump energy to threshold level over the 2-10 range, with the rhodamine laser tuned to the 566 nm wavelength. The results indicate the optimum conditions for ensuring less than 20

instability of emission time delay and emission pulse duration attainable by distributed-feedback dye lasers. Figures 4; references 3 : 2 Russian, 1 Western.

02415/06662

#### **Kinetics of Slow Electrons in Excimer Laser With Electron-beam Pumping**

18620191a Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 5, May 87 pp 937-942

[Article by V.A. Adamovich, A.v. Demyanov, N.A. Dyatko, I.V. Kochetov, A.P. Napartovich, and A.P. Streltsov, Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk; manuscript received 24 Mar 86]

[Abstract] Gas mixtures with Ar as principal component used as active media of excimer lasers are considered, of concern being the kinetics of slow electrons in such lasers with electron-beam pumping. Accordingly, the corresponding Boltzmann equation and equations of ion-molecular kinetics are solved simultaneously for the

low-energy part of the electron energy-distribution function. The kinetic model of such an excimer laser is constructed on this basis, first for the simplest case of pure Ar and then for Ar with an active gas such that dissociative attachment of electrons to its molecules can serve as measure of the electron concentration. An experiment was performed with an Ar:CCl<sub>4</sub> = 1000:1 mixture. Next are considered homogeneous Ar-Xe-HCl mixtures, for which that system of equations has been solved by numerical simulation in accordance with an applicable computer program deck. The kinetic model for such active media includes ionization and excitation of Ar and Xe atoms by beam electrons as well as by secondary electrons, multistage and Penning ionization as well as photoionization, charge transfer, excitation transfer and quenching during collisions with atoms, molecules, or electrons, excitation of vibrational states in HCl, dissociative attachment of electrons to HCl molecules in vibrationally excited states as well as in the ground state, also spontaneous and stimulated radiation emission as well as radiation absorption by ions and excited particles. On the basis of this model has been calculated the electron-beam current density as a function of time for a pumped Ar:Xe:HCl = 1500:150:6 mixture under a total pressure of 2.2 atm. Lowering of the attachment frequency is found to increase the low-energy fraction of beam electrons and thus to decrease the mean beam energy. Complete elimination of attachment, by removal of HCl, is found to lower the mean beam energy still further. So can photoionization and photodetachment. The form of the energy distribution function for plasma electrons was found not to change appreciably with change of the energy spectrum of the low-energy electron source from a Gaussian to a rectangular or triangular one. Figures 6; references 15: 7 Russian, 8 Western (1 in Russian translation).

02415/06662

#### **Solid-state Ring Laser With Acoustooptical Phase Nonreciprocity of Opposing Waves**

18620186b Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 917-919

[Article by Yu.D. Golyayev, A.A. Zadernovskiy, and A.L. Livintsev; manuscript received 31 Oct 86]

[Abstract] An experiment was performed with a YAG:Nd<sup>3+</sup> ring laser and an acoustooptic device for maintenance of phase nonreciprocity of opposing light waves interacting with each other as well as with the traveling component of the ultrasonic wave. The laser was placed inside a cavity with a 120 cm long perimeter and was pumped with a power not higher than 1.5 kW. An AOM-1 acoustooptic modulator of light intensity with the traveling ultrasonic wave of constant power continuously present was first used as the phase nonreciprocator. The dynamic characteristics of opposing standing light waves were measured with FD24K photodiodes and on a 30 MHz wide S1-74 oscillograph, these characteristics depending on the orientation of the phase

nonreciprocator  $gv$  and on its microwave input power  $P_{mw}$ . The spectrum of opposing light waves was scanned by a Fabry-Perot etalon with a 3 cm long base. Measurements made with  $P_{mw} = 1.5$  W yielded the dependence of the phase difference  $gDg$  between opposing light waves and of their intensities  $I'/I_0$ ,  $I''/I_0$  on the deviation  $gDgv = gv - gv^0$  of the phase nonreciprocator orientation from that corresponding to the Bragg angle  $gv_0$  over the  $gDgv = 0 \pm 20^\circ$  range. Measurements made with  $gDgv/3^\circ$  yielded the dependence of intensities  $I'/I_0$ ,  $I''/I_0$  on the microwave input power  $P_{mw}$  over the 0-4 W range. The results indicate suppression of one of the opposing waves upon introduction of phase nonreciprocity. The experiment was repeated with locking of longitudinal modes by means of an ML-202 acoustooptic device instead of light intensity modulation. Analogous measurement of  $gDg$  and  $I'/I_0$ ,  $I''/I_0$  as functions of  $gDgv$ , with a microwave input power  $P_{mw} = 2$  W and a 0.1 W power of the traveling ultrasonic wave, have yielded results which indicate that in this case phase nonreciprocity becomes zero and bidirectional emission of light waves with nearly equal intensities begins as the orientation  $gv$  of the acoustooptic mode locking device deviates more than approximately  $6^\circ$  from the Bragg angle. Figures 3; references 9: all Russian.

02415/06662

#### Emission Characteristics of XeCl-Laser Excited by Electron Beam of Microsecond Duration

18620186g Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 953-956

[Article by Yu.I. Bychkov, N.G. Ivanov, V.F. Losev, G.A. Mesyats, and V.V. Ryzhov, Institute of High-Current Electronics, Siberian Department, USSR Academy of Sciences, Tomsk; manuscript received 25 Apr 86]

[Abstract] An experimental study of an XeCl-laser excited by an electron beam of microsecond duration was made, for a determination of its space and time as well as energy characteristics including relation between emission and excitation parameters. The active medium, an HCl:Xe:Ar gas mixture with HCl:Xe = 1:20 or a CCl<sub>4</sub>:Xe:Ar gas mixture with CCl<sub>4</sub>:Xe = 1:30 occupying a volume of 30 dm<sup>3</sup>, was excited by an electron beam from an accelerator with a sputter-emission cathode. The vacuum diode was energized by a 10-stage Arkadyev-Marx generator with a 1K-100-0.4 capacitor bank. An approximately 300 keV electron beam of approximately 1.3 gms total duration and with a current density up to 15 A/cm<sup>2</sup> was injected into the laser chamber through a 13x15 cm<sup>2</sup> large window of 50 gmm thick dacron film. The chamber with walls made of stainless steel had a 800 dm<sup>3</sup> capacity. The laser radiation was extracted either through a plane-parallel quartz plate 10 cm in diameter, with the other mirror aluminum-coated, or through a cellular array of three plane mirrors 9 cm in diameter with dielectric coating each. Power and energy were measured, pulse form was recorded with an FK-20

photodiode and on an S8-13 oscillograph, but the distribution of absorbed electron beam energy over the Ar volume was calculated by the Monte Carlo method. The results have yielded the specific excitation energy as a function of time over the 1.3 gms pulse duration period and as a function of the distance from the film-window up to 14 cm inside the chamber, with the Ar pressure varied over the 1-3 atm range. The specific emission energy was found to decrease with increasing distance from the film-window, from a higher initial value at the window and at a faster rate as the Ar:HCl or Ar:CCl<sub>4</sub> ratio was decreased from 4250 to 2500, with little difference between HCl and CCl<sub>4</sub>. The results reveal a generally nonuniform excitation of the active medium by an electron beam, which makes optimization of the laser performance difficult, and that at low excitation levels the Cl content necessary for an optimum gas mixture decreases with decreasing excitation power. A specific energy of 4 J/dm<sup>3</sup> with an efficiency of 2, with a saturation intensity of 0.3 MW/cm<sup>2</sup> and with a ratio of small-signal gain to unsaturated-absorption coefficient  $g_0/g_a = 10$ , was obtained with a specific excitation power of 0.3 MW/cm<sup>3</sup>. Figures 4; references 11: 6 Russian, 5 Western. 02415/06662

#### Effects of Emission Energy Transient in Periodic-pulse XeCl Excimer Laser of Approximately 400 W Average Power

18620186f Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 936-942

[Article by V.M. Borison, A.Yu. Vinokhodov, and Yu.B. Kiryukhin, Institute of Atomic Energy imeni I.V. Kurchatov, Moscow; manuscript received 1 Apr 86]

[Abstract] An experimental study of the periodic-pulse XeCl excimer laser with electric-discharge pumping was made, for an analysis of the emission energy transient and a comparative evaluation of two buffer gases. The excitation system consisted of two independent identical electric circuits and two gas-discharge spaces with a common ground-potential electrode but with a separate high-potential electrode each, all electrodes made of stainless steel. Reliable switching was ensured by use of hydrogen-filled thyatrons. Tests were performed with two gas mixtures, namely a conventional HCl:Xe:He - 1:101000 one and a new HCl:Xe:Ne - 1:10:1200 one. The total pressure was varied over the 2-4 atm range. The ratio of peaking capacitance to storing capacitance in the discharge circuit was 0.6 for He as buffer component and 1.0 for Ne as buffer component under a total pressure of 4 atm. Sequences of emission pulses at repetition rates of 100-500 Hz building up to a steady-state average power were recorded on oscillograms. An evaluation of the data reveals the advantages of Ne over He as buffer component, namely a much better maintenance of discharge uniformity and a higher attainable steady-state average power of 420 W approaching that attainable in the monopulse emission mode. The authors thank V.P. Novikov for helpful discussion w-of the results. Figures 4; references 12: 8 Russian, 4 Western.



02415/06662

**Tunable Condensed-media Laser With Antiresonant Ring Cavity**

18620196b Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 46, No 5,  
May 87 pp 727-732

[Article by G.S. Kruglik, A.A. Kutsak, G.A. Skripko, V.r. Sender, N.v. Kondratyuk, and L.P. Zharikhina; manuscript received 8 Jul 85]

[Abstract] An antiresonant ring cavity with negative feedback is considered for tuning a condensed-media laser. Such a cavity is formed by two 60SDC-angle plane high-reflectance mirrors with the active medium between them on a common axis and a beam-splitting semireflecting plane exit mirror perpendicular to that axis with a 90SDC-angle third high-reflectance plane mirror behind it. The performance of such a cavity is analyzed comparatively with that of a linear one where a 90SDC-angle mirror replaces the 60SDC-angle mirror behind the active medium and the exit mirror emits two orthogonal half-intensity beams instead of feeding back and then emitting one full-intensity beam, also with that of a conventional ring cavity where the beam-splitting exit mirror is parallel to the axis through the active medium. The field inside the cavity is resolved into those of individual modes and is described by corresponding equations of balance. The resulting system of equation is solved, with the relative populations of all levels adding up to unity, using specific numerical data applicable to a rhodamine-6G dye laser. On this basis is calculated the dependence of the nonreciprocity index on the reflection coefficient of the exist mirror and, for a 50-reflectance exit mirror, the dependence of the emission energy on the distance from that mirror to the high-reflectance mirror behind it. The results indicate that stable emission of two waves traveling in opposite directions with mutually aiding interaction and a thus nearly constant nonreciprocity index is more likely in an antiresonant ring cavity than in a conventional one, the selectivity of an antiresonant ring cavity being higher than that of a linear one. They also indicate, however, that the emission energy depends more strongly on the distance between the exit mirror and the mirror behind it in an antiresonant ring cavity than in a linear one, the emission energy increasing as the distance is decreased. Figures 4; references 8: 5 Russian, 3 Western.

02415/06662

**Thermal Stability of Silicon Layers After Ion Implantation and Laser Annealing**

18620195c Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 46, No 4,  
Apr 87 pp 578-583

[Article by S.A. Batishche, N.I. Danilovich, V.a. Mostovnikov, A.M. Pristrem, and G.A. Tatur; manuscript received 27 Dec 85]

[Abstract] An experimental study of Si:Sb substitutional solid solutions was made for a determination of their thermal stability after laser treatment. Layers of KDB-0.3 (11) silicon were doped with 60 keV Sb<sup>+</sup> ions by implantation to doses of  $6.25 \cdot 10^{14}$ - $5 \cdot 10^{15}$  cm<sup>-2</sup> and then, at various temperatures ranging from 20SD to 400SDC, treated with radiation from a YAG:Nd<sup>3+</sup>-laser with amplifier in pulses of 50 ns duration over a spot 20 mm in diameter. Some layers were treated with radiation of  $\lambda_1 = 1.06$  gmm wavelength, the energy density being varied over the 1-5 J/cm<sup>2</sup> range. Some layers were treated with radiation of  $\lambda_2 = 0.53$  gmm wavelength, the energy density being varied over the 0.3-2 J/cm<sup>2</sup> range. The laser beam was in each case nonpolarized with a nearly uniform energy distribution over the cross-section, free of hot spots. All layers were subsequently annealed in a diffusion furnace at various temperatures covering the 600-1220SDC range for 5-30 h, in either a nitrogen atmosphere or an oxygen atmosphere. Thermal stability was determined on the basis of electrical surface-resistance measurements before and after heat treatment. The results indicate different optimum ranges of energy density for the two laser radiation wavelengths. These measurements and the Sb concentration profiles in Si layers, determined in an electron diffractometer as well as on the basis of electrical resistance measurements with successive etching away of slices, indicate that such solutions remain thermally stable after annealing in a nitrogen atmosphere at temperatures up to 1050SDC only, if the maximum Sb concentration after annealing will not exceed 2-3 times the maximum equilibrium solubility limit and the defect concentration after laser treatment has been minimum. Supersaturation and subsequent interaction of excess Sb with defects are, accordingly, the principal cause of thermal instability. Figures 2; tables 1; references 10: 2 Russian, 8 Western (2 in Russian translation).

02415/06662

**Quantitative Analysis of One-photon and Two-photon Absorption Spectra Recorded by Intracavity Laser Spectroscopy**

18620195b Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 46, No 4,  
Apr 87 pp 573-578

[Article by V.M. Bayev, V.F. Gamaliy, E.a. Sviridenkov, D.D. Toptygin, and O.I. Yushchuk; manuscript received 12 Dec 85]

[Abstract] Quantitative absorption-spectrum analysis on the basis of highly sensitive intracavity laser spectroscopy is shown to be feasible even when the instrument resolution is much larger than the width of spectral lines, especially in the case of two-photon absorption. The method of total absorption is appropriately modified for intracavity laser spectroscopy and then applied also to one-photon absorption, an absorption line here being closely approximated by a Voigt contour. The integral cross-section for one-photon or two-photon absorption,



including all relevant coefficient can then be precisely calculated by measurement. The method was tested on two-photon absorption in potassium vapor in the cavity of a dye laser (DOTS in dimethyl sulfoxide) pumped by a ruby laser. Not only were three absorption lines detected, namely 766.01 nm, 769.11 nm, and 769.17 nm, but also for the first time the cross-sections for two-photon absorption  $(9.2 \pm 2.3) \cdot 10^{-11} \text{ cm}^2/\text{J}$  at the  $4^2S_{1/2} - 6^2S_{1/2}$  transition,  $(2.1 \pm 0.4) \cdot 10^{-13} \text{ cm}^2/\text{J}$  at the  $4^2S_{1/2} - 4^2D_{3/2}$  transition, and  $(0.7 \pm 0.2) \cdot 10^{-13} \text{ cm}^2/\text{J}$  at the  $4^2S_{1/2} - 4^2D_{5/2}$  transition were determined. The error, within 30, was determined principally by the accuracy with which the concentration of potassium atoms had been measured. Figures 2; references 9: 7 Russian, 2 Western (both in Russian translation).

02415/06662

#### Nonlinear Stage of Ultrashort-pulse Formation in Solid-state Laser

18620195a Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 46, No 4,  
Apr 87 pp 562-567

[Article by M.I. Demchuk, I.A. Manichev, V.P. Mikhaylov, and K.V. Yumashev; manuscript received 10 Dec 85]

[Abstract] Formation of ultrashort pulses in a YAG:Nd<sup>3+</sup>-laser is considered, particularly in nonlinear stage. The dependence of the resulting pulse duration on the length of this stage as well as on the length of the free-emission stage and on the density of a passive shutter is evaluated on the basis of experimental data and computer-aided numerical analysis of the applicable theoretical relation. In the experiment an approximately 2400 mm long cavity for the laser crystal was formed by a spherical mirror having an  $r = 250 \text{ mm}$  radius of curvature with an  $R_1 = 0.997$  reflection coefficient and a plane exit mirror with an  $R_2 = 0.50$  reflection coefficient. Six different materials were used for a passive shutter in contact with the spherical mirror: 3274 dye in acetone solution, one with 0.92 density and one with 0.25 density, 5752 dye in dichloroethane solution with 0.28 density, 4050 film in polymethyl methacrylate, one with 0.57 density and one with 0.37 density, 2681 film in cellulose diacetate. By shifting the laser crystal along the cavity, two-threshold condition was attained with the free-emission threshold and the mode-locking threshold coinciding. Calculations were based on the differential equation of pulse duration kinetics with respect to the number of passes through the nonlinear stage of emission buildup and yielded the change of fluctuational overswing duration on the shutter relaxation time as well as on the number of passes through the cavity, with the length of the nonlinear stage held constant and varied respectively, taking into account small-signal absorption and with the pulse intensity resolved into three parts including a constant threshold in addition to two parts depending on the number of passes: one linearly and one exponentially. The results reveal that it is possible to

decrease the duration of ultrashort pulses by lengthening the nonlinear stage and shortening the linear one, under two-threshold condition, and that sufficient lengthening of the nonlinear stage will eventually saturate the shutter effect. Lowering the density of some shutters such as 4050 film in polymethyl methacrylate was found to decrease the pulse duration, while lowering the density of others such as 3274 dye in acetone solution increases it. Figures 4; tables 1; references 4: 2 Russian, 2 Western.

02415/06662

#### High-efficiency Y-Sc-Ga:Cr<sup>3+</sup>,Tu<sup>3+</sup>,Ho<sup>3+</sup> Garnet Laser (gl = 2.088 gmm at Room Temperature 18620186e Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 922-923

[Article by A.N. Alpatyev, Ye.V. Zharikov, S.P. Kalitin, A.F. Umyskov, and I.A. Shcherbakov, Institute of General Physics, USSR Academy of Sciences, Moscow; manuscript received 25 Dec 87]

[Abstract] Improvement have been made on the pulsed laser at the Ho 5/7-5/8 transition in a Y-Sc-Ga garnet crystal with optical pumping at room temperature. A cylindrical garnet crystal 4 mm in diameter and 76 mm long was doped with Cr<sup>3+</sup> and Tu<sup>3+</sup> ions as well as Ho<sup>3+</sup> ions to concentrations of  $2.5 \cdot 10^{20} \text{ cm}^{-3}$ ,  $8 \cdot 10^{20} \text{ cm}^{-3}$ , and  $5 \cdot 10^{19} \text{ cm}^{-3}$  respectively. Such a crystal was placed inside a 24 cm long cavity between two plane mirrors with dielectric coating each, one having a 99.23% reflectance and the exit mirror having a 50% reflectance. Without coating on its front and back surfaces, the crystal was pumped over a 72 mm long segment by an INP-5/75A xenon lamp in an elliptical monoblock made of silver-coated yellow quartz filtering out ultraviolet radiation. It was cooled with 0.1 K<sub>2</sub>CrO<sub>4</sub> solution in H<sub>2</sub>O acting also as supplementary filter. The nearly square pumping pulses were of 1.4  $\mu\text{s}$  duration and thus much shorter than the 13  $\mu\text{s}$  lifetime of the excited Ho<sup>3+</sup> state. The emission threshold was found to be 63 J pump energy. Free emission at a wavelength within the 2008  $\pm$  4 nm band with a differential efficiency of 3.1% was attained by pumping with pulses of 142 J energy at a repetition rate of 1 Hz, the maximum absolute efficiency of 2.1% having been attained by pumping with pulses of 253 J energy and the maximum emission energy of 7.4 J having been attained by pumping with pulses of 395 J energy. Figures 1; references 1: Russian.

02415/06662

#### Emission of Tunable Radiation by BeAl<sub>2</sub>O<sub>4</sub>:Ti<sup>3+</sup> Laser Pumped With Pulses of Coherent Radiation at High Repetition Rate 18620186d Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 919-922

[Article by Ye.V. Pestryakov, V.I. Trunov, and A.I. Alimpiyev, Institute of Thermophysics, Siberian Department, USSR Academy of Sciences, Novosibirsk; manuscript received 1 Dec 86]

[Abstract] An experimental study of a  $\text{BeAl}_2\text{O}_4$  laser crystal grown by the Czochralski method and doped with  $\text{Ti}^{3+}$  ions to a concentration of  $2.3 \cdot 10^{10} \text{ cm}^{-3}$  was made, for a determination of its emission characteristics under longitudinal pumping by a  $\text{YAG:Nd}^{3+}$  laser in pulses of coherent second-harmonic radiation at repetition rates of 3-15 kHz. An LTI-707 continuous-wave  $\text{YAG:Nd}^{3+}$  laser with intracavity frequency doubling served as the pump. Its pulses were of 150-200 ns duration at the 0.53  $\mu\text{m}$  wavelength, much shorter than the 4.9 gmm wavelength and at 0.7-0.95 gmm wavelengths respectively. The pumping radiation was focused by a lens with 8.5 cm focal length on the crystal, whose front and back surfaces had no transmissive coating. The emission threshold power was minimized by axial movement of this lens and of the plane exit mirror into appropriate positions relative to the fixed spherical mirror and crystal between them. Measurement of the emission characteristics over the 0.7-0.95 gmm range of wavelengths, after the radiation has passed through filters and an "SRM-2" monochromator, followed by calculations on the basis of applicable power relations and assuming exponential luminescence kinetics indicate that one can optimize the performance of a chrysoberyl laser, increase its efficiency, by improving the optical precision of the crystal and the distribution of  $\text{Ti}^{3+}$  ions in it. The authors thank V.P. Chebotayev and G.V. Bukin for support. Figures 4; references 6: 2 Russian, 4 Western.

02415/06662

**Space-time Structure of Ultrashort Light Pulses Formed During Stimulated Backscattering of Laser Beam**

18620186i Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 1025-1030

[Article by E. Gayzhauskas, A. Piskareskas, V. Smilgyavichyus, and K. Stalyunas, Vilnyus State University imeni V. Kapsukas; manuscript received 5 May 86]

[Abstract] Conditions for optimum compression of nanosecond light pulses by stimulated Mandelstam-Brillouin backscattering of a focused laser beam in an active medium are analyzed theoretically, taking into account nonuniform intensity distribution over the laser beam cross-section and that Stokes reflection occurs within rather than outside the focal constriction. Calculations are based on a system of two short equations which describe interaction of an incident pump wave and the reflected Stokes wave during quasi-steady stimulated Mandelstam-Brillouin scattering, assuming slow envelopes, these equations have been derived from the hydrodynamic equations for a variable-density medium and the Maxwell field equations. They have been solved by the numerical method of sum approximation for Gaussian and hyper-Gaussian incident laser beams, also for incident laser beams with uniform intensity distribution. The dependence of the energy reflection coefficient and the pulse compression ratio on the excess of the actual pump energy above the emission threshold level

and on the focusing angle is derived together with the space-time structure of a reflected Stokes pulse and its dependence on the focusing angle. The results indicate how compression of nanosecond light pulses into subnanosecond ones can be optimized, namely by use of a uniform incident laser beam with suboptimum pump energy less than twice the threshold level for the scattering medium and by its wide-angle focusing so as to minimize the space-time nonuniformity of the reflected Stokes pulse. High compression ratios of the order of 10 are attainable with two or more compression and amplification stages. Figures 3, references 9: 6 Russian, 3 Western.

02415/06662

**Controlling XeCl-Laser by Means of External Signal With Less Than  $2 \text{ W/cm}^2$  Intensity**

18620186h Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 5, May 87 pp 957-958

[Article by Yu.I. Bychkov, M.L. Vinnik, S.Ye. Kovalenko, and V.F. Losev, Institute of High-Current Electronics, Siberian Department USSR Academy of Sciences, Tomsk; manuscript received 15 Sep 86]

[Abstract] The conditions for controllability of an XeCl-laser by synchronous injection of a signal from a master laser have been established in the first experimental study of this kind, with the intensity of such an external signal varied from  $7 \text{ mW/cm}^2$  to  $2 \text{ W/cm}^2$  corresponding to the intensity range of spontaneous noise in the active medium. The controlled laser and the master laser had each electric-discharge excitation with a plasma electrode. The active medium of the controlled laser was an  $\text{HCl:Xe:Ne} = 1:5:750$  gas mixture occupying a volume of  $53 \text{ cm}^3$  under a total pressure of 3 atm, this laser emitting pulses of 5 mJ energy and 60 ns duration in the free-emission mode with two lines corresponding respectively to 0-1 transition and 0-2 transition in the B-X band. The cavity for this laser was 1.8 m long, formed by a spherical mirror with aluminum coating and a convex glass lens. Two diaphragms with a hole 12 mm in diameter each were placed inside. This telescopic resonator had a x4 magnification. The active medium of the master laser was an  $\text{HCl:Xe:He} = 1:5:500$  gas mixture occupying a volume of  $126 \text{ cm}^3$  under a total pressure of 3 atm, this laser being tunable to 0-0, 0-1, 0-2, 0-3 transitions in the B-X band with a  $\text{gDgl} = 5 \text{ pm}$  wide spectral line. For the injection experiment it was tuned to the center of the 0-1 transition ( $\text{gl}_c = 307.96 \text{ nm}$  wavelength). The cavity for this laser was formed by a plane 30% reflectance mirror and two diffraction gratings with 1200 lines/mm each, inside this cavity having also been placed a diaphragm with a hole 1.5 mm in diameter. A radiation pulse of 15 ns duration and with a 0.3 mrad beam divergence angle from the master laser was injected into the cavity of the controlled laser through a translucent 50% reflectance mirror near the convex lens. Emission energy was measured with an IMO-2M instrument, power and pulse form were recorded with FEK-22

and FK-20 photodiodes as well as with an S8-14 spectrograph and a 6LOR spectrograph, spectral characteristics were measured with an STE-1 spectrograph and an IT-28-30 interferometer. The injection efficiency  $\eta = 1 - W_1^{0.1} W_2^{0.2} / W_1^{0.2} W_2^{0.1}$  was found to reach a maximum of 95 with an external signal of  $2 \text{ W/cm}^2$  intensity and to drop to zero, corresponding to loss of controllability, with an external signal of  $7 \text{ mW/cm}^2$  or

lower intensity. It was also found to drop appreciably when the time difference between filling the controlled-laser cavity with radiation from the master laser and reaching the controlled-laser emission threshold exceeded  $\pm 4 \text{ ns}$ . Figures 2; references 6: 1 Russian, 5 Western.

02415/06662

**Irreversible Transition From Blocking To Channelling for Ions Scattered by Ge Single Crystal**

18620189e Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 5, May 87 pp 1008-1012

[Article by S.A. Karamyan, Laboratory of Nuclear Reactions, Joint Institute of Nuclear Research]

[Abstract] Study of the shadow effect during interaction of heavy 0.6-8 MeV ions and a metal or semiconductor crystal has revealed channelling peaks in the angular distribution of  $^{20}\text{Ne}$  and  $^{40}\text{Ar}$  ions scattered by a Ge single crystal. In the experiment a polished 0.5 mm thick Ge plate with (100) orientation was bombarded with 104 MeV  $^{20}\text{Ne}$  ions and with 205 MeV  $^{40}\text{Ar}$  ions from a U-300 cyclotron, the ion beams having a diameter of 1 mm and an intensity not higher than  $10_{10} \text{ s}^{-1}$  with an angular spread smaller than  $\pm 1\text{SD}$  after passage through a collimator. Their scattering by the target crystal in a reflection geometry was recorded over the

30-80SD range of angles, scattering of  $^{20}\text{Ne}$  ions with a track detector made of dacron covered by a 6 mm thick aluminum foil and scattering of  $^{40}\text{Ar}$  ions with a track detector made of bare glass which also recorded recoiling Ge nuclei. The results indicate that the shadow effect during recording of the products of the nuclear ( $^{20}\text{Ne}, \text{Ge}$ )-reaction with a glass detector is suppressed not because the reaction time is long but because recording of  $^{20}\text{Ne}$  ions with a glass detector is a near-threshold process and thus possible only for low-energy ions. From the experimental data can also be estimated the dechannelling distance and deduced the mechanism of dechannelling, which suppresses the shadow effect, namely rescattering or angular disordering. The author thanks the U-300 cyclotron operating team at the Laboratory of Nuclear Reactions for producing ion beams and the participants of the seminar at the Laboratory of Nuclear Reactions for helpfully discussing the interpretation of the results. Figures 3; references 8; 4 Russian, 4 Western (1 in Russian translation).

02415/06662



**Measuring Speed of Muon Transfer From Mesic Deuterium Atom to Mesic Tritium Atom**

18620185a Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 92, No 5, May 87 pp 1543-1548

[Article by D.V. Balin, V.A. Volchenkov, A.A. Vorobyev, An.A. Vorobyev, A.I. Ilin, V.K. Kapyshov, Ye.M. Mayev, M.P. Malek, V.P. Maleyev, A.A. Markov, V.I. Medvedev, G.Ye. Petrov, L.B. Petrov, L.A. Rivkis, G.A. Ryabov, G.G. Semenchuk, and Yu. V. Smirenin, Leningrad Institute of Nuclear Physics imeni B.P. Konstantinov, USSR Academy of Sciences; manuscript received 4 Dec 86]

[Abstract] In a study concerning muon catalysis of di-synthesis, the speed of muon transfer from a deuterium atom to a tritium atom in the ground state to a muon atom in the ground state  $(Dgm)_{1s} + t \rightarrow (tgm)_{1s} + d$  was measured by recording  $^4\text{He}$  nuclei in a high-pressure ionization chamber. Measurements were made with a  $D+1.24 \pm 0.02T$  mixture under a pressure of 84.3 atm at a temperature of 296 K. muons with a momentum of  $70 \pm 7$  MeV/c were passed through three thin scintillation-counter plates and then a window in the protective container into the ionization chamber. The second scintillation counter served to monitor absence of another muon during recording of events. The ionization chamber operated with a cathode 30 mm in diameter at a -30 kV potential and a hexagonal anode bundle consisting of 19 strands 3.1 mm in diameter each at zero potential, the distance between them being 10.5 cm and a regular grid of wires 0.025 mm in diameter 0.2 mm apart at a -4 kV potential placed between them 0.5 cm from the anode. The chamber was first filled with pure tritium, whereupon extra-pure deuterium was added. The electric field intensity in the cathode-grid space corresponded to 40 recombination of the number of ion pairs formed in the D-T mixture by a 3.53 MeV  $^4\text{He}$  nucleus.

An evaluation of the data, including statistical analysis of the amplitude spectra of di-synthesis and dd-synthesis events by the Monte Carlo method, has yielded not only the rate of muon decay and the rate of muon interception but then also the sought rate of muon transfer  $g_{dt}^{O_2} = (2.8 \pm 0.2) \cdot 10^8 \text{ s}^{-1}$  and an approximately 50 times lower rate when both mesic atoms are in corresponding excited states. This value agrees closely with those obtained in earlier experiments but exceeds by a factor of 1.4 the theoretically predicted one. The authors thank L.I. Ponomarev, N.P. Popov, and V.M. Suvorov for productive discussions. Figures 2; tables 1; references 8: 5 Russian, 4 Western.

02415/06662

**'Gas' Approximation in Nonlinear Theory of Stability for Kortweg—De Vries Solitons**

18620185b Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 92, No 5, May 87 pp 1612-1617

[Article by S.K. Zhdanov and B.A. Trubnikov; manuscript received 6 Mar 86, after revision 8 Jan 87]

[Abstract] Large perturbations and stability of Kortweg—de Vries soliton are analyzed in the "ideal monoatomic (!) gas" approximation of a nonlinear theory on the basis of the corresponding Kadomtsev-Petviashvili equation and its particular solution. A general solution is obtained for the case of a two-dimensional medium with that equation being completely integrable and reducible to the simple Laplace equation. References 19: 15 Russian, 4 Western (1 in Russian translation).

02415/06662

**Alfven Waves in Plasma With Finite Ion Temperature**

18620185c Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 92, No 5, May 87 pp 1612-1617

[Article by V.P. Lakhin, A.B. Mikhaylovskiy, and A.I. Smolyakov, Moscow Institute of Engineering Physics; manuscript received 7 Feb 86, after revision 12 Dec 86]

[Abstract] A hydrodynamical description of nonlinear Alfven waves is sought which will also cover Alfven vortices in a plasma with the ion temperature higher than the electron temperature and the ratio of plasma pressure to magnetic field pressure larger than the ratio of ion mass to electron mass. Assuming that the Larmor radius as well as the temperature of ions are finite, a system of nonlinear equations of the Grad kind is found to be adequate where equations of the Braginskii kind are not. This system reduces to a single equation, inasmuch as the dispersion of Alfven waves is weak and thus approximately linear. This equation is linear for standing waves and remains so for waves traveling in opposite directions from singular lines. Its solution demonstrates the existence of Alfven dipole vortices, which belong in the class of degenerate bipotential ones. References 17: 10 Russian (1 in English translation), 7 Western.

02415/06662

**Strongly Coupled Spinless Solitons on Discrete Peierls Mode**

18620185d Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 92, No 5, May 87 pp 1822-1827

[Article by J. Hronek, Moscow State University imeni M.V. Lomonosov]

[Abstract] The discrete exactly integrable analog of the continuous model describing Peierls transitions in dielectric compounds such as  $\text{MX}_3$  ( $M=\text{Nb, Ta}$  and  $X=\text{S, Se, Te}$ ) is analyzed, considering that the Peierls effect can cause strong self-localization and thus may produce spinless charged solitons. The equations of this model are solved exactly, first for a linear array of atoms and not more than two electrons per atom. With only the two terms  $kI_2$  and  $kI_4$  but not the term  $PI_0$  retained in the

sum of integrals representing the potential (strain) energy of such a lattice, the solution reveals that there can exist coupled states of two electrons and two Froehlich domain walls or simply coupled states of two domain walls without localized additional electrons. A stable spectrum of states in a biperiodic plane structure is then considered with four forbidden bands and with E-E symmetry, assuming that the Fermi level  $\mu$  and  $\mu$  each pass through a forbidden band. Here the solution yields the energy and the electric charge, both depending on the total particle concentration in the array, while analysis of the model yields the conditions under which only polarons or also bipolarons exist. References 7: 6 Russian, 1 Western (in Russian translation).

02415/06662

**Antineutrino Production of Charmed Charged Vector Mesons**

18620197a Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 45, No 10,  
25 May 87 pp 453-455

[Article by A.E. Asratyan, P.A. Gorichev, S.P. Kruchinin, M.A. Kubantsev, I.V. Makhlyuyeva, A.V. Fedotov, V.G. Shevchenko, and V.I. Shaklyan, Institute of Theoretical and Experimental Physics, Moscow, V.V. Ammosov, V.S. Burtovoy, V.A. Gapiyenko, G.S. Gapiyenko, A.G. Denisov, V.G. Zayets, V.I. Klyukhin, V.I. Koreshev, P.V. Pitukhin, V.I. Sirotenko, Ye.A. Slobodyuk, and Z.U. Usebov, Institute of High-Energy Physics, Serpukhov]

[Abstract] Following measurement of the cross-section for production of D<sup>-</sup>-mesons in  $\bar{\nu}_\mu N$ -interactions by the "semiinclusive" method, the  $\bar{\nu}_\mu N \rightarrow \mu^- + D^{*-} + X$  reaction and the subsequent D<sup>-</sup>-gp-D<sup>0</sup> decay have been analyzed for estimation of the D<sup>-</sup>-X yield. This was done by sorting and scaling of data on about 6400 charged-current  $\bar{\nu}_\mu N$ -interactions within the 10-200 GeV energy range recorded in the 15-foot bubble chamber with heavy neon+hydrogen and a 35 GeV mean-energy antineutrino beam at the F.N.A. Laboratory, rather than by direct tracking of excessively short-lived D<sup>0</sup>-mesons. According to this estimate, the D<sup>-</sup>-meson yield constitutes 5.5 $\pm$ 2.2 of all charged-current  $\bar{\nu}_\mu N$ -interactions, which agrees closely with estimates based on those previous measurements. The authors thank their colleagues at the F.N.A. Laboratory and at the University of Michigan for the contribution to the experiment during its first stage. Figures 1; tables 1; references 5: all Western.

02415/06662

**Possibility of Baksan Underground Scintillation Telescope at Institute of Nuclear Research at USSR Academy of Sciences Having Recorded Neutrino Signal on 23 February 1987**

18620197b Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 45, No 10,  
25 May 87 pp 461-464

[Article by Ye.N. Alekseyev, L.G. Alekseyeva, V.I. Volchenko, and I.V. Krivosheina, Institute of Nuclear Research, USSR Academy of Sciences; manuscript received 6 Apr 87]

[Abstract] The underground scintillation telescope in the Baksan Neutrino Observatory (Institute of Nuclear Research, USSR Academy of Sciences), located under Mt. Andrychi in the Northern Caucasus and tracking the Galaxy continuously since June 1980, consists of 3156 standard detectors arrayed in four horizontal and four vertical planes. Each detector is a 30x70x70 cm<sup>3</sup> large cell filled with organic scintillator substances on a C<sub>n</sub>H<sub>2n+2</sub> (n9) base. The array is scanned by an FEU-49 photomultiplier. This telescope is most sensitive to electron antineutrinos, which free scintillator protons absorb according to the  $\bar{\nu}_e + {}^{12}\text{D} \rightarrow {}^{12}\text{N} + e^-$  reaction. An analysis of acquired data and theoretical estimates indicate that this telescope may have recorded a neutrino signal on 23 February 1987 at 2:52:36 Ural Time, while the Japanese KAMIOKANDE II facility and the American IMB facility have recorded it at 7:35:35 Ural Time and 7:35:41 Ural Time, respectively. This hypothesis needs to be verified by a more thorough analysis of all signals recorded at all facilities prior to the optical spike. The authors thank A.Ye. Chudakov and G.T. Zatsepin for productive discussion. Figures 1; tables 1; references 6: 1 Russian, 5 Western.

02415/06662

**Theoretical Analysis Yielding Radiative-recoil Corrections for Muonium**

18620188d Moscow ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 92, No 4, Apr 87 pp 1188-1200

[Article by S.G. Karshenboym, V.a. Shelyuto, and M.I. Eydes, All-Union Scientific Research Institute of Metrology imeni D.I. Mendeleyev]

[Abstract] Hyperfine splitting in the ground state of muonium is considered, muonium being a purely electrodynamic system, and refinement of its theory is sought to match the results of fairly accurate measurement. Corrections of  $g\alpha(Z\alpha)(m/M)$  order explicitly accounting for radiative recoil upon radiative insertion into the electron line and thus linear with respect to the ratio  $m/M$  of electron mass to nucleus mass ( $Z$ - ratio of nucleus charge to electron charge) are calculated using the equivalent Dirac equation of two-particle formalism, the relativistic correction of order  $(Z\alpha)^2(M/m)$  and the

correction of order  $ga(Zga)^2$  independent of that ratio having already been calculated on the basis of the Breit equation and the Bethe-Salpeter equation respectively. Diagrams are subsequently constructed, using the Fried-Yennie gauge, which yield graphically all components of the radiative-recoil correction  $ga(Zga)E_F$  to the Fermi splitting energy. An analytical expression for this correction is then derived for standard conditions. A numerical evaluation yields 4.05kHz. It may be necessary to also calculate corrections of order  $ga^2(Zga)$ . Figures 2; references 25: 3 Russian, 22 Western.

02415/06662

# **Anharmonicity and Solitons in Molecular Chains**

18620188a Moscow ZHURNAL

EKSPERIMENTALNOY I TEORETICHESKOY

FIZIKI in Russian Vol 92, No 4, Apr 87 pp 1366-1375

[Article by A.N. Orayevskiy and M.Yu. Sudakov, Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences; manuscript received 13 May 86]

[Abstract] a mechanism of energy transfer by solitons in biological molecules such as DNA molecules following hydrolysis of ATP is proposed, vibrations of C=O bonds (amide-I) in peptide groups by dipole-dipole interaction being inefficient because of attendant energy dissipation and Davydov solitons having been shown to be suppressed by thermal noise at normal biological temperatures already. The new mechanism involves localization of these vibrations as a consequence of their intrinsic anharmonicity. The mathematical model of this mechanism is constructed for a one-dimensional chain of like molecules having an internal vibration degree of freedom each. It is based on the Hamiltonian and corresponding equations of motion for an infinite chain of interacting identical dipoles in the approximation of nearest neighbors only, inasmuch as the dipole-dipole interaction potential is a very short-range one. The classical equation of a harmonic oscillator yields excitons in the linear approximation ( $g=0$ ), with a nonlinear dispersion law already when  $g$  is small. In the case of small wave number and low velocity this equation becomes the nonlinear Schrodinger equation and its solution, by the "inverse problem of scattering" method, yields solitons sustained rather than suppressed by higher harmonics. This is demonstrated by analogy to the Sine-Gordon equation, one exact solution to which is a "brezer," while anharmonicity accordingly ensures stability of such solitons. However, exciton-phonon and then soliton-phonon interaction may cause local deformation of the molecular chain such as  $\alpha$ -helical albumin molecule and acceleration of a soliton beyond the velocity of sound. The authors thank S.V. Amelkin and other participants of the seminar held by the Department of Theoretical Radio-physics at the Institute of Physics imeni P.N. Lebedev for discussion and helpful comments. Figures 3; references 14: 9 Russian, 5 Western (1 in Russian translation).

02415/06662

# **Theory of Radiation Emission by Ultrarelativistic Charged Particle in Magnetic Field in Matter**

18620188c Moscow ZHURNAL

EKSPERIMENTALNOY I TEORETICHESKOY

FIZIKI in Russian Vol 92, No 4, Apr 87 pp 1161-1172

[Article by S.P. Andreyev and A.V. Koshelkin, Moscow Institute of Engineering Physics; manuscript received 15 Jul 86, after revision 10 Oct 86]

[Abstract] A consistent theory of radiation emission by an ultrarelativistic classical charged particle moving through matter parallel to an external magnetic field is constructed, considering the case of elastic multiple scattering of such a particle by atoms of the matter. The radiation pattern and spectrum are calculated exactly, both being functions of time after entry of such a particle and higher radiation intensity shifting toward shorter waves. A uniform magnetic field and a random space distribution of scattering atoms are assumed here. Both angular and frequency distributions of magnetic bremsstrahlung under conditions of negligible scattering are calculated, for an evaluation of the interdependent effects which a magnetic field and a scattering medium have on the spectral intensity and energy distributions of radiation emitted by such a particle. The authors thank V.I. Ritus for discussing the results and Yu.A. Gurvich for helpful comments. Figures 2; references 15: 9 Russian, 6 Western (2 in Russian translation).

02415/06662

# **Theory of Muon Method for Study of Solid and Liquid Hydrogen**

18620188b Moscow ZHURNAL

EKSPERIMENTALNOY I TEORETICHESKOY

FIZIKI in Russian Vol 92, No 4, Apr 87 pp 1151-1159

[Article by Yu.M. Belousov and V.P. Smilga, Moscow Institute of Engineering Physics; manuscript received 9 Jun 86, after revision 22 Sep 86]

[Abstract] Exothermic reaction  $H_2 + gm^+ \rightarrow (H_2^+gm)^+ + 4.5$  eV as well as less likely endothermic exchange reactions  $Mu + H_2 \rightarrow MuH + H$  or  $gm^+ + H_2 \rightarrow MuH + H^+$  are considered for study of solid and liquid hydrogen. The spin density matrix with appropriate formulation of the spin Hamilton is evaluated, for an analysis of the behavior of muon polarization in the diamagnetic  $(H_2gm)^+$  ion frozen into the c.p.h. lattice and subsequent analysis of internal spin interaction. Depolarization, occurring at about the same rate of the order of  $10^5$  s<sup>-1</sup> in solid para-hydrogen in a solid ortho-hydrogen, is shown to be slowed down by rotational diffusion of the  $(H_2gm)^+$  ion. Depolarization in liquid hydrogen is known to be slowed down by Brownian movement of the ice shell forming



around the  $(H, g_m)^+$  ion. Depolarization should theoretically, therefore, become much slower during melting of hydrogen. This has been confirmed experimentally. References 22: 11 Russian, 11 Western (3 in Russian translation).

02415/06662

**Angular Distribution of Radiative Energy Lost by Ultrarelativistic Electrons During Axial Channeling in Single Crystals**

18620188e Moscow *ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI* in Russian Vol 92, No 4, Apr 87 pp 1201-1214

[Article by S.V. Beslaneyeva and V.I. Telegin]

[Abstract] A method of calculating the angular distribution of radiative energy lost by free GeV electrons during axial channeling in single crystals is outlined, this method being based on classical electrodynamics. Transverse-energy and angular-momentum distributions of such electrons, both depending on the penetration depth, are obtained from the solution to the equation of kinetics which describe derailing of such electrons as a result of scattering by bound electrons of atoms and by thermal vibrations of the crystal lattice. Numerical calculations have been made for 0.9-10 GeV electrons in up to 10 mm thick silicon single crystals and 4.5 GeV electrons in up to 10 mm thick diamond single crystals axially channeled and quasi-channeled upon entry at angles not exceeding  $1.7g_{wc}$  ( $g_{wc}$  - critical entry angle), considering the essentially nondipole radiation emission by electrons within this energy range with a  $g_{wc} \approx 0.96$  nondipolarity factor in Si. The results are in satisfactory agreement with available experimental data. Figures 5; tables 1; references 35: 23 Russian, 12 Western (1 in Russian translation).

02415/06662

**Spectrum and Polarization of Electrons Produced by  $gB$ -decay of Neutron in Field of Electromagnetic Wave**

18620194b Tomsk *IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA* in Russian Vol 30, No 3, Mar 86 pp 33-37

[Article by O.F. Dorofeyev, A.Ye. Lobanov, O.S. Pavlova, and V.N. Rodionov, Moscow State University imeni M.V. Lomonosov; manuscript received 30 Nov 84]

[Abstract] Production of electrons by  $o$ -decay of a neutron in the field of a circularly polarized electromagnetic wave is considered, its probability according to the Yukawa-Anderson theory being based on the assumption of a quiescent neutron and a nonrelativistic proton also produced by such a decay. The spectral and angular distribution of these electrons as well as their polarization are calculated as functions of the wave parameters,

ignoring the Coulomb proton-electron interaction. In the approximation of small  $gI - gq/m$  ( $gq$  - wave frequency,  $m$  - electron mass), not exceeding  $10^{-6}$  in modern lasers, the results reveal that no electrons are emitted in the direction of wave propagation but that the distribution becomes narrower while its maximum approaches this direction as  $gy = eE/mgq$  increases ( $e$  - electron charge,  $E$  - electric field intensity). The angular distribution is twice as wide and the spectrum is half as wide in the energy model than in the quasi-energy model. The total probability of  $gB$ -decay does not depend on the wave parameters and, therefore, such a decay produces a partly polarized electron beam with the degree of polarization independent of  $gy$ . All this characterizes drift of electrons, thus the only likely mechanism of electron emission during  $gB$ -decay of a neutron in the field of an electromagnetic wave. The authors thank L.I. Lapidus, B.K. Kerimov, and G.A. Chizhov for interest and productive discussions. Figures 2; references 12: all Russian.

02415/06662

**Structural and Phase Transformations of Carbide-hardened  $Ni_3Al$ -base Alloys at High Temperatures**

18620194c Tomsk *IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA* in Russian Vol 30, No 3, Mar 86 pp 55-58

[Article by M.K. Kasymov, Yu.R. Kolobov, A.D. Korotayev, N.I. Afanasyev, V.P. Buntushkin, and L.V. Larina, Siberian Institute of Engineering Physics imeni V.D. Kuznetsov, Tomsk State University; manuscript received 4 Jul 85]

[Abstract] An experimental study of dispersion-hardened heat-resistant Ni alloys with  $Ni_3Al$  in the hardening of  $\gamma$ -phase was made, this phase being known to dissolve and lose strength at temperatures above 1273 K. Specimens of such an alloy were annealed at temperatures of 1423-1581 K and aged at correspondingly lower temperatures of 1350-1473 K, in a He atmosphere rather than under vacuum so as to avoid depletion of alloying elements in the surface layers. For metallographical examination under a "Neophot" microscope, specimens were polished first mechanically and then electrolytically in an  $8CH_3COOH + 2HClO_4$  electrolyte under a voltage of 26 V. Subsequent chemical etching was done with a 30 ml  $HNO_3 + 10$  ml  $H_2SO_4 + 10$  ml  $H_3PO_4 + 5$  ml  $CH_3COOH$  mixture. Thin foils for microstructural examination under an EM-200 electron microscope were produced with the same electrolyte, by jet action of a latter under a voltage of 190 V. Chemical and phase analysis were done in a DRON-3 x-ray diffractometer and with a "Camebax" electronic-probe microanalyzer. Thermal stability was determined on the basis of differential thermal analysis with a "Rigaku Denki" instrument, while specimens were heated in an Ar atmosphere at a rate of 0.17 K/s. The volume fractions of carbide phases were measured by the method of selective dissolution. The results reveal formation of  $Cr_7C_3$  beginning



at 1473 K mostly along grain boundaries and its subsequent dissolution beginning at 1573 K with attendant formation of (+) -phase regions and Cr enrichment, followed by an endothermic reaction beginning at 1573 K which embrittles the alloy with attendant formation of a disordered -phase and catastrophic drop of strength to zero during melting of the —C eutectic. An alloy suitable for higher service temperatures must, therefore, contain carbide-forming elements enrichment with which will not destabilize the -phase. Figures 1; references 9: 7 Russian, 2 Western.

02415/06662

**Anomalous Structural Phase Transformation of  $\text{CrAs}_{1-x}\text{Sb}_x$  Alloys and Its Dependence on Sb Content**

18620187e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, Apr 87 pp 1227-1229

[Article by S.A. Buzhinskiy, E.a. Zavadskiy, N.A. Romanova, and I.A. Sibarova, Donetsk Institute of Engineering Physics, UkSSR Academy of Sciences; manuscript received 21 Aug 86, in final version 13 Oct 86]

[Abstract] An experimental study of  $\text{CrAs}_{1-x}\text{Sb}_x$  (0.46  $x$  0.52) alloys was made, for the purpose of determining the sensitivity of the anomalous B8<sub>1</sub>-B31 transition to the Sb content ( $x$ ) on the basis of magnetic susceptance and electrical resistance measurements as well as thermal differential analysis and structural examination. Four alloys with  $x = 0.46, 0.48, 0.50, 0.52$  respectively were tested. Magnetic measurements revealed a shifting of the anomaly in the temperature dependence of the susceptance toward lower temperatures with increasing Sb content and an attendant increase of the transition hysteresis from 4 K ( $x = 0.46$ ) to 29 K ( $x = 0.52$ ). Electrical measurements revealed a lowering of the stability of the B31 phase and its "double helix" magnetic ordering with an increase of the Sb content as well as an attendant increase of the resistance jump  $R/R_0$  ( $R_0$  - electrical resistance at room temperature) from 4.4 ( $x = 0.46$ ) to 65 ( $x = 0.52$ ). These results, supported by thermal differential analysis and x-ray structural examination confirm the hypothesis that lowering of the crystallographic symmetry by rhombic distortions produces an  $g_{\text{q}}$  energy gap in the spectrum of d-electrons and a change of the conductivity type as the Sb content increases. Since an attendant jump of volume was not recorded during phase transition, the dominant effect of increasing the Sb content must be lowering of the transition temperature with a corresponding decrease of the phonon component of electrical conductivity rather than abatement of structural distortions. Accordingly, only with  $x = 0.52$  does a metal - semiconductor transformation occur during B8<sub>1</sub>-B31 transition. With  $x = 0.46, 0.48, 0.50$  the respective transition temperatures are too high for the condition  $g_{\text{q}} = g_{\text{q}0} - nK$  ( $g_{\text{q}0}$  - energy gap in absence of distortions,  $n$  - electron concentration,  $K$  - electron-phonon interaction constant) to be satisfied. Figures 2; references 4: 2 Russian, 2 Western.

02415/06662

**Microscopic-scale Estimate of cluster Formation in Light Nuclei**

18620189a Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 5, May 87 pp 884-889

[Article by V.G. Zelevinskiy and V.V. Mazepus, Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences]

[Abstract] Formation of ga-clusters is considered, an important hypothesis aiding the interpretation of experimental data on nuclear structure including data on form factors which characterize elastic and inelastic collisions. Estimates of modified finite-range Skyrme forces  $SI_{\text{L}}, \dots, SVI$  which take into account overlap of nucleon orbits rather than rely on the bare quasi-molecule model indicate that energy test functions of the Block-Brink microscopic-scale model have competing minima according to a cluster configuration just as according to a plain shell configuration. This is demonstrated by calculating the bond energy, the r.m.s. radius, and the cluster parameter of  $^{16}\text{O}$  nucleus which correspond to various values of the interaction parameter on the basis of two interaction modes with a cluster minimum and a spherical minimum respectively. The calculations include averaging one-particle and two-particle operators over states and over Gaussian orbitals, taking into account attraction forces and specifically Coulomb forces. Tables 1; references 30: 6 Russian, 24 Western (4 in Russian translation).

02415/06662

**Inductive Linotron With Three-dimensional Beam Orbit**

18620182c Leningrad ZHURNAL TEKHNIЧЕСКОЙ FIZIKI in Russian Vol 57, No 4, Apr 87 pp 721-728

[Article by V.f. Babenko, V.D. Zyuzin, and V.N. Kanunnikov, Moscow Institute of Radio Engineering, USSR Academy of Sciences; manuscript received 12 Feb 85]

[Abstract] The inductive version of a recirculatory particle accelerator (linotron) is considered in preference to classical cyclic accelerators such as the betatron on account of the much larger and discrete energy increment per loop, its advantages being not only fewer necessary loops and a shorter acceleration time but also elimination of resonance effects. An inductive linotron for accelerating an electron beam shorter than the transport channel from 0.5 MeV to 2 MeV has a toroidal magnetic field component 2-3 kG strong for an electron beam with a current density of approximately 1 kA/cm<sup>2</sup>. The transport channel consists of two curvilinear segments in a horizontal plane, two halves of a split torus with a 100 cm median radius, separated by two parallel 500 cm long rectilinear segments. The accelerating system, between two rotatable magnets, is built into one of

these rectilinear segments. Solenoids on each rectilinear segments produce a horizontal magnetic field, while rotatable focusing magnets on each curvilinear segment produce a toroidal magnetic field as strong as the horizontal one and also a uniform vertical one. The orbit inside this channel is  $N = 4$  turns. Such a three-dimensional orbit for discrete increments of electron momentum is formed in a stationary helical magnetic field, with soft rather than rigid packing of the electron beam attained by means of a toroidal magnetic field component which is uniform along the orbit. Quantitative design analysis of the linotron components, its accelerating system as well as all magnets takes into account distortion of both magnetic and electric fields nominally uniform in space and constant in time as well as field distortions due to periodicity of the magnet structure but ignores negligible effects of curvilinearity of the two trajectory segments. The design is readily modifiable for accelerating electron beams to 10 MeV. Figures 3; references 5: all Russian. 02415/06662

**Dependence of Cross-section for (gap)-Reaction on Even-even Ni Isotopes on Atomic Number of Target Nucleus**

18620189b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: SERIYA FIZICHESKAYA in Russian Vol 51,  
No 5, May 87 pp 908-975

[Article by A.v. Smirnov, A.Ye. Antropov, and P.P. Zarubin, Scientific Research Institute of Physics, Leningrad State University]

[Abstract] An experimental study of the (gap)-reaction on even-even Ni isotopes was made, for the purpose of determining the dependence of its probability on the

isotopic composition of the target and describing the attendant proton emission. The experiment was performed with  $24.70 \pm 0.07$  MeV  $\alpha$ -particle beams from the cyclotron at the Leningrad State University and four sets of  $0.2\text{--}0.4$  mg/cm<sup>2</sup> self-sustaining foils enriched with  $99.7^{58}\text{Ni}$ ,  $99.3^{60}\text{Ni}$ ,  $97.2^{62}\text{Ni}$ ,  $93.1^{64}\text{Ni}$  respectively. Angular and energy distributions of protons emitted in each case were recorded with a telescope consisting of two semiconductor devices, namely a 70 gmm thick surface-barrier device serving as gDE-detector and a 2.5 mm thick Si(Li) drift device serving as E-detector. Use of an autonomous CAMAC-crate monitor ensured high-speed operation and use of a special particle identifier facilitated sorting of particles prior to computer-aided numerical analysis of events. The cross-sections for this reaction as calculated according to the non-statistical theory of pre-equilibrium decay, where the mean-square of the matrix element representing residual interaction is the principal argument and the only adjustable parameter, or according to the generalized Manzauranis-Weidenmuller-Agassi exciton theory do not agree with predictions on the basis of the statistical Howser-Feshbach theory. A phenomenological model is therefore sought and the relation  $d^2\sigma/dU.d\Omega.dgQe^{-\pi^2/g^2Q}$  for the second derivative of cross-section  $\sigma$  with respect to excitation energy  $U$  and solid angle  $\Omega$  ( $gQ_0$  - critical angle weakly dependent on the excitation energy and on the isotope of the target nucleus) is found to approximately describe the experimental data on its angular distribution over the 3-7 MeV range. Figures 6; references 6: 1 Russian, 5 Western.

02415/06662

**Spectroscopic Indicators of TiO Amorphization  
Near Point of Anatase—Rutile Transformation**  
18620192g Leningrad OPTIKA I SPEKTROSKOPIYA  
in Russian Vol 62, No 4, Apr 87 pp 946-947

[Article by Ya.S. Bobovich and M.Ya. Tsenter; manuscript received 3 Nov 86]

[Abstract] The drastic change in the Raman scattering spectrum of  $\text{TiO}_2$  during its transition from anatase form to rutile form, which has been recorded upon stimulated bulk crystallization of a lithium-aluminosilicate complex matrix with small  $\text{TiO}_2$  impurity during secondary heat treatment, is interpreted as a result of intermediate  $\text{TiO}_2$  amorphization at temperatures about 950SDC. This hypothesis is supported by physical measurements as well as by chemical and spectral analysis. Figures 1; references 10: 6 Russian, 4 Western.

02415/06662

**Effect of Doping on Refractive Index of InP at  
Edge of Fundamental Absorption Band**  
18620192e Leningrad OPTIKA I SPEKTROSKOPIYA  
in Russian Vol 62, No 4, Apr 87 pp 926-929

[Article by V.B. Bogdanov, V.T. Prokopenko, and A.D. Yaskov; manuscript received 16 Jun 86]

[Abstract] An experimental study of InP crystals was made, for the purpose of precisely determining the dependence of the refractive index  $n(g)$  and its dispersion  $dn/dg$  at the  $g = 1$  gmm edge of the fundamental absorption band on the doping level and thus on the concentration of free n or p charge carriers. Accordingly, InP single crystals grown by the Czochralski method were doped to  $n = 10^{16}$ - $2 \cdot 10^{18}$   $\text{cm}^{-3}$  or  $p = 5 \cdot 10^{16}$ - $4 \cdot 10^{18}$   $\text{cm}^{-3}$  concentrations. The refractive index was measured by the prism method at a temperature of  $20 \pm 0.2$ SDC. Increments  $gDn$  of the refractive index and  $gD(dn/dg)$  of its dispersion were determined at the  $g = 1$  gmm edge and at wavelengths down to  $g = 0.922$  gmm corresponding to the width of the straight forbidden band. The results reveal a Burstein-Moss effect in n-InP and p-InP. The density of state in the conduction band being low in n-InP and high in p-InP, however, the forbidden band has been found to shift toward smaller wavelengths throughout the entire doping range in n-InP but only throughout the strong-doping range in p-InP. Figures 2; references 8: 3 Russian, 5 Western (1 in Russian translation).

02415/06662

**Theory of Surface-Magnetostatic-Wave Excitation,  
Part 2: Numerical Results and Comparison With  
Experimental Data**

18620191b ZHURNAL TEKHNIЧЕСКОЙ ФИЗИКИ in  
Russian Vol 57, No 5, May 87 pp 943-952

[Article by I.M. Shcheglov, I.A. Gilinskiy, and V.G. Sorokin, Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk; manuscript received 19 Mar 86]

[Abstract] A rigorous theory of surface-magnetostatic-wave excitation in microstrip transmission lines has been constructed with use of the complex propagation constant for electromagnetic waves in ferrite lines, the characteristic impedance of such lines, and the electromagnetic-to-magnetostatic wave transformation ratio. Excitation of such waves was then analyzed numerically on the basis of this theory by means of computer-aided calculations. This involved solving the corresponding Fredholm integral equation of the second kind for the current density at the microstrip electrode, by expansion of that current density into an infinite series of Legendre polynomials with complex coefficients and thus conversion of that equation into a finite system of linear algebraic equations with the number of series terms retained depending on the desired accuracy. Assuming a  $k_0 d / l$  ( $k_0$  - wave number,  $d$  - distance from electrode to substrate of strip line) rendered the effect of a metal substrate on the wave spectrum negligible so that it could be ignored in this analysis. Calculations yielded the frequency dependence of the complex propagation constant, of the characteristic impedance and of its resistive component, also of the wave transformation ratio for a specific microstrip line with given geometrical dimensions ( $d = 1$  mm) and electrophysical properties (dielectric constant of ferromagnetic film  $g\epsilon_f = 15$  and of insulator  $g\epsilon_i = 12.5$ ), with the thickness of the ferromagnetic film varied over the 1-50  $\mu\text{m}$  range and its material either at saturation ( $H_0 = 1750$  Oe,  $gq_0 = 1/3gq_m$ ). These results are compared with experimental data on the frequency dependence of the radiation resistance and of the input impedance pertaining to lines with wide film strips and to lines with narrow film strips on substrates of correspondingly different thicknesses. The theory is found to be correct, on the whole, but to require refinement such as proper accounting for edge effects so as to become consistent with results of measurements over the entire range of existence of surface magnetostatic waves. Figures 6; references 11: 8 Russian, 3 Western.

02415/06662

**Holographic Disk for Data Storage**  
18620186j Moscow KVANTOVAYA ELEKTRONIKA in  
Russian Vol 14, No 5, May 87 pp 1074-1085

[Article by A.L. Mikaelyan, A.F. Vanin, E.Kh. Gulanyan, and S.A. Prokopenko; manuscript received 4 Mar 86]

[Abstract] The feasibility of high-density data storage on a holographic disk is examined on the basis of appropriate schemes for recording and readout of digital optical signals. Equipment necessary and available for this purpose is described, the performance of principal component devices being evaluated for optimization with reference to signal and carrier characteristics as well as to holograph geometry. Theoretical analysis of the problem and experimental results already reported indicate the scope of applications for the holographic disk and attainable disc quality for data storage. Figures 16; references 19: 12 Russian, 7 Western.

02415/06662

#### Variant of Correlation Spectroscopy

18620196d Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 46, No 5,  
May 87 pp 798-803

[Article by E.L. Altman, A.I. Lopatin, and Yu.P. Turunov; manuscript received 5 Feb 86]

[Abstract] A variant of correlation spectroscopy is described which combines the simplicity of dispersionless gas filters and the high selectivity of masking devices in fluorescence-correlation absorption teleanalyzers. The recorded signal is shown to be proportional to the desired gas concentration and the sensitivity threshold is shown to be determined by the signal-to-noise ratio, assuming weak Lambert-Beer absorption of light along its propagation path. Analytically derived expressions indicate that this method is at least as sensitive as or more sensitive than gas filters, especially upon extension from a single absorption line to molecular absorption bands. This has been further confirmed by a laboratory experiment with molecular iodine in air. Figures 1; references 5: 3 Russian, 2 Western.

02415/06662

#### Characteristics of Spectroscopic Determination of Hydrogen Isotopes in Mixtures With Neon and Argon

18620196a Minsk ZHURNAL PRIKLADNOY  
SPEKTROSKOPII in Russian Vol 46, No 4,  
May 87 pp 719-723

[Article by V.M. Nemets, A.A. Petrov, and A.A. Solov'yev; manuscript received 27 Jan 86]

[Abstract] Spectroscopic determination of the isotopic effect, namely of the coefficient  $K$  in the relation  $K_{H/I_D} = K(C_{H_2}/C_{D_2})$  characterizing the dependence of the ratio  $I_H/I_D$  (measured intensities of atomic hydrogen and atomic deuterium lines) on the ratio  $C_{H_2}/C_{D_2}$  (measured concentrations of molecular hydrogen and molecular deuterium) in a luminous gas-discharge, is considered when both hydrogen isotopes exist in a mixture with an inert gas such as Ne or Ar and reactions with metastable atoms and ions of that gas complicate the determination. An experimental study of the o-line in the Balmer series ( $\lambda_H = 486.1$  nm,  $\lambda_{D/I_H-D} = 0.13$  nm) has yielded the desired dependence of this coefficient on both pressure of the mixture and concentration of both isotopes in it, on the basis of measurements made during high-frequency discharge in a quartz tube 6.5 mm in diameter containing  $H_2+D_2+Ne$  or  $H_2+D_2+Ar$  under pressures covering the 10-80 kPa range with the concentration  $C_{H_2}+D_2$  covering the 0.0001-1.0 mol. range. An analysis of the data indicates that the pressure dependence of the isotope effect is determined by the balance between competing reactions and their rates, exchange and ion-molecular reactions tending to raise the concentration of hydrogen atoms with association and dissociative excitation tending to raise the concentration of deuterium atoms. At low hydrogen-deuterium concentration, moreover, the rate of dissociative excitation is determined by the balance between increasing concentration of metastable Ne or Ar atoms and decreasing concentration of  $H_2+D_2$  molecules. Accordingly, there are optimum conditions for spectroscopic determination of hydrogen isotopes in such mixtures with minimum error and in this particular case with Ne or Ar the optimum pressure is 50 kPa. Figures 1; references 11: all Russian.

02415/06662



**Three-wave Parametric Resonance in Plasma of Relativistic Electron Flux**

18620182b Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 4, Apr 87 pp 687-694

[Article by T.A. Davydova, V.P. Zakharov, and V.V. Kulish, Dnepropetrovsk Institute of Construction Engineering, Simferopol branch; manuscript received 24 Jan 85]

[Abstract] Three-wave parametric resonance in the plasma of a relativistic electron flux is treated in terms of Raman or Compton interaction and development of burst-like instabilities with the amplitudes of interacting waves increasing nonlinearly after the linear stage is demonstrated to occur during Compton interaction. The model of this phenomenon is based on a relativistic electron flux drifting in one direction with a mean velocity and with compensation of its space charge by an ambient ion cloud. Considering only the steady state after a finite transient period of oscillation buildup, a system of five nonlinear first-order differential equations for slowly varying complex amplitudes  $E_{11}$ ,  $E_{12}$ ,  $E_{21}$ ,  $E_{22}$ ,  $E_3$  is obtained by expansion of the corresponding kinetic equations with respect to amplitudes of interacting electromagnetic waves and by averaging over phases of fast oscillations, an important factor being that the interacting waves are differently polarized. A linear dispersion law indicates that two slowly decaying space-charge waves can be excited in the plasma, namely a fast one and a slow one, the difference between their phase velocities being very large in a dense plasma. In the corresponding Raman interaction mode only one of these waves participates in resonance with electromagnetic waves assumed here, for simplicity, to be linearly polarized. As the pump amplitude  $(E_{11}^2 + E_{12}^2)^{1/2}$  becomes so large that the ponderomotive potential exceeds the space-charge potential, in the Compton interaction mode, both waves participate equipotently in resonance with electromagnetic waves. Here again the latter are assumed to be linearly polarized. Instabilities in this mode are calculated with the aid of appropriate modifications of Manly-Rowe integrals and the condition for synchronism, which yield the law of momentum conservation in the system as well as the sufficient conditions for development of an ordinary burst-like instability in it and, at sufficiently high pump intensity, also a modified burst-like instability. The amplitudes of space-charge waves decrease then in the same manner as in the Raman interaction mode, but the amplitudes of electromagnetic waves increase much faster. Such an instability is shown to develop only in a non-equilibrium medium with the energy of a relativistic electron flux, for instance, as source of unbalance. References 20: 13 Russian, 7 Western (1 in Russian translation).

02415/06662

**Effect of Flow Convergence on Turbulence Level in Stream**

18620190a Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Mar-Apr 87 pp 146-152

[Article by G.I. Derbunovich, A.s. Zemskaya, Ye.U. Repik, and Yu.P. Sosedko, Moscow; manuscript received 7 Mar 86]

[Abstract] An experimental study of stream contraction in interchangeable converging nozzles of a subsonic wind tunnel was made, for the purpose of determining the effect of such a contraction on the turbulence level in the diffuser. The nozzles were 200 mm long each, the velocity of the stream did not exceed 30 m/s, tests were performed with the nominal contraction ratio  $C = 2, 4$ , and  $8$  respectively. In order to ensure reliable measurement of the ratio of absolute longitudinal velocity fluctuation to average longitudinal velocity at the stream axis, after contraction, these fluctuations had to be much larger than acoustic perturbations in the test segment. Accordingly, turbulence at the nozzle entrance was intensified to a larger scale by means of special grids (wire diameter  $d = 1-6$  mm, mesh size  $M = 4-23$  mm correspondingly) before it and acoustic perturbations at the exit from the test segment were abated by means of a fine grid-manipulator (wire diameter  $d = 0.25$  mm, mesh size  $M = 1$  mm) before the diffuser. This latter grid facilitated breakdown of the boundary layer at the diffuser entrance and streamlining of the diffuser walls so as to lower the probability of separation. A theoretical evaluation of the experimental data, indicating negligible degeneracy of turbulence in the nozzle on account of molecular viscosity, has yielded semiempirical relations for the decay of turbulence along the channel:  $gy(x/M)^{0.95}$  at  $x/M$  and  $gy(x/M)^{-0.7}$  at  $x/M \geq 20$  ( $x/M$  - distance from end of contraction zone, referred to mesh size of turbulizing grid), with the equivalent turbulence suppression coefficient  $F_s = C^{4/3}$ . Figures 4; references 12: 4 Russian, 8 Western.

02415/06662

**Stability of Solitons Quasi-longitudinally Propagating Through Plasma With Hall Dispersion**

18620190b Moscow IZVESTIYA AKADEMII NAUK SSSR: MEKHANIKA ZHIDKOSTI I GAZA in Russian No 2, Mar-Apr 87 pp 159-165

[Article by M.S. Ruderman, Moscow; manuscript received 7 May 86]

[Abstract] A soliton is considered which propagates through a quasi-neutral plasma containing electrons and single-charge ions of one kind, assuming that the parameters of this plasma remain almost constant over a period of time much longer than the mean free time. The plasma is treated as a perfect gas with negligible viscosity and thermal conductivity, but with the product of mean

free time and cyclotron frequency for electrons not smaller than unity so that Hall currents and Joule heating become significant. From the corresponding system of equations of hydrodynamics is obtained an extension of the nonlinear Schrodinger with a first-order derivative to not quite one-dimensional propagation nonlinear waves with small amplitude and then to oblique propagation of a soliton, this extension being analogous to that of the Korteweg-deVries equation for solitons in weakly dispersive media. On the basis of this extension is analyzed the stability of such a soliton with respect to multidimensional very-large-scale perturbations and is established the limit above which perturbations will build up exponentially. References 18: 7 Russian, 11 Western.

02415/06662

#### **Development of Electromagnetic Showers in Medium With Crystalline Structure**

18620189c Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 5, May 87 pp 086-993

[Article by I.M. Nadzhafov, L.V. Mirantsev, and M.R. Radszabov, Azerbaijan State University imeni S.M. Korov]

[Abstract] The cascade theory is used for describing generation of electromagnetic showers by elementary particles such as an electron, positron, or photon moving through a medium. First is considered a particle penetrating an amorphous medium and moving through some layer of it with an energy above the  $750/Z$  MeV threshold ( $Z$  - charge number of medium atoms). Then is considered a single crystal and a particle moving through it at some angle to one of its crystallographic axes. Into account are taken coherence of  $\gamma$ -quanta and bremsstrahlung emitted by an electron or positron, also photogeneration of  $e^+e^-$  pairs. Calculations in each case are based on the method of Laplace-Mellin transformation, which yields the energy and depth distribution of shower particles. The general analytical results applicable to any single crystal are used for an interpretation of experimental data pertaining to showers generated by a 100 GeV particle beam with a 1.5 mrad divergence angle in 6,11,20 cm thick Si single crystals. It is possible to determine on this basis the ratio of the total number of charged shower particles in an "oriented" Si single crystal, when the particles move say along the axis, to the total number of charged shower particles in an amorphous medium and the dependence of this ratio on the crystal thickness. Figures 1; references 10: 5 Russian, 5 Western.

02415/06662

#### **Dependence of $\beta^{\pm}$ -decay Processes on Quiescent Mass of Electron Neutrino and Heavy Neutrino**

18620189d IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 51, No 5, May 87 pp 944-1001

[Article by B.K. Kerimov, N.V. Samsonenko, Chhotu Lal Kathat, and A.I. Elgavhari, "Friendship of Nations" University imeni P. Lumumba and Moscow State University imeni M.V. Lomonosov]

[Abstract] The effect of mixing a light neutrino  $\nu_1$  and a heavy neutrino  $\nu_2$  on the parameters of nuclear  $g\beta^{\pm}$ -decays is evaluated, these parameters including differential probability of such a decay, degree of longitudinal polarization of electrons or positrons, coefficient of angular electron-neutrino or positron-neutrino correction, and coefficient of charge asymmetry. Nuclei with any spin are considered, the purpose of this evaluation being to establish the effect of a non-zero quiescent mass of both neutrinos. Calculations are made for allowed transitions:  $0^+-0^+$  (Fermi transitions,  $a = 1$  and  $b = 0$ ),  $1^+-0^+$  (Gamov-Teller transitions,  $a = 0$  and  $b = 1$ ), mixed ( $a=b=1$ ). Calculations for  $g\beta$ -decay of a free polarized neutron with attendant emission of electrons and antineutrinos characterized by an asymmetry with respect to the direction of the neutron spin and by a three-particle correlation, matched with and adjusted to experimental data, yield an upper bound of 2.3 keV for the quiescent mass of an electron antineutrino. Figures 2; references 13: 8 Russian, 5 Western.

02415/06662

#### **Stabilization of Vallecular Perturbations in Axisymmetric Open Trap by Means of Sloshing Ions**

18620193a Moscow FIZIKA PLAZMY in Russian Vol 13, No 4, Apr 87 pp 403-411

[Article by I.A. Kotelnikov, G.v. Roslyakov, and D.D. Ryutov, Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences; manuscript received 30 Jun 86]

[Abstract] The feasibility of achieving MHD stability in an isotropic plasma in an axisymmetric open klystron with vallecular perturbations is examined theoretically on the basis of the Rosenbluth-Longmire criterion. First is established the condition for stability, which requires integration by parts. Then injecting a beam of monoenergetic sloshing ions with minimum initial divergence angle is proposed as means of plasma stabilization, these ions being much more rapidly stopped and neutralized by plasma electrons than stopped and scattered by plasma ions. The corresponding kinetic equation is solved for the fast-ion distribution functions, assuming that a long cylinder through the center of the trap contains most of the homogeneous plasma. The case of fast ions with a lifetime much longer than their stopping

and neutralization time is considered, when the minimum injection energy necessary for plasma stabilization must be sufficiently lowered. This is shown to be achievable by coupling two klystrons, a long one and a short one to which the paraxial approximation still applies, with the magnetic field optimally shaped so as to make the lifetime of fast ions much shorter than their stopping and neutralization time. Ions are then injected into the long klystron and vallecular perturbations are stabilized by the short klystron. Figures 3; references 5: 2 Russian, 3 Western.

02415/06662

**Ion-Acoustic Solitons and Electron Holes in Current-Carrying Plasma**

18620193b Moscow FIZIKA PLAZMY in Russian Vol 13, No 4, Apr 87 pp 435-442

[Article by B.I. Meyerson and I.V. Rogachevskiy, Institute of Applied Geophysics imeni Ye.K. Fedorov; manuscript received 6 Feb 86]

[Abstract] Existence and structure of ion-acoustic solitons and electron holes in a current-carrying plasma are analyzed theoretically, the problem of a moving ion-acoustic solitons being reducible to the problem of a stationary electron hole when treated in a system of co-moving coordinates. First the linear space and velocity distribution function is established for electrons and for ions in the one-dimensional approximation. From the resulting phase portrait the stationary distribution function for drift electrons and for adiabatically trapped ones is determined together with their concentration profiles and the ion concentration profile. Next the electric field distribution is calculated, which indicates the conditions for existence of ion-acoustic solitons and electron holes. Their existence is shown to be impossible in a highly nonisothermal plasma containing cold ions when the current is sufficiently high. Further calculations yield the maximum current under which their existence is still possible, also their maximum possible amplitudes under conditions allowing their existence. Figures 5; references 12: 4 Russian, 8 Western.

02415/06662

**Langmuir Solitons in Plasma Containing Resonant Atoms**

18620193c Moscow FIZIKA PLAZMY in Russian Vol 13, No 4, Apr 87 pp 490-493

[Article by I.V. Bachin and D.V. Krasovitskiy, Rostov State University imeni M.a. Suslov; manuscript received 14 Feb 87]

[Abstract] Envelope solitons in a plasma which still contains atoms are considered and interaction of these atoms and Langmuir oscillations is analyzed, taking accordingly into account strictive nonlinearity of electrons which compensates diffusion of Langmuir waves

and resonance which occurs when the frequency of atomic transitions approaches the Langmuir frequency. Nonlinearity of the plasma being weak and nonlinearity of the atoms being strong then, the presence of resonant atoms lowers the group velocity of these waves. The dispersion law is determined from a self-consistent system of two equations describing Langmuir waves in a plasma-gas medium, disregarding relaxation process and thus applicable to sufficiently short pulses only. The authors thank V.B. Krasovitskiy for discussion and helpful comments. References 7: 6 Russian, 1 Western.

02415/06662

**Pulse Duration Control of XeCl\*-Laser by Means of Plasma Shutter**

18620193d Moscow FIZIKA PLAZMY in Russian Vol 13, No 4, Apr 87 pp 497-498

[Article by A.N. Panchenko and V.F. Tarasenko, Institute of High-Current Electronics, Siberian Department, USSR Academy of Sciences; manuscript received 11 May 86]

[Abstract] For the first time a plasma shutter was used for pulse duration control of a XeCl\*-laser, radiation pulses being shortened here by the plasma of an opaque target material closing a hole made in the target. Experiments were performed with a LIDA-10 XeCl\* exciplex laser, which normally emitted pulses of 60 ns duration with up to 2 J energy. The radiation was focused by a 10 cm long lens on the target so as to ignite a plasma at surface of the latter, over a spot 1 mm in diameter. Thin metal and dacron films were first used as the target in which the laser beam burned out holes. Pulse compression occurred during the first few shots, after which the holes widened sufficiently to render such a shutter ineffective. Next 1 mm thick plates of metal, tin, and lead, already having holes approximately 0.1 mm in diameter were used as the targets. Within plates it was possible to shorten the duration of 0.1 J pulses to 7 ns and to lengthen the shutter life to tens of pulses. This shutter was found to be much more effective than 1 mm thick saturable filter made of RVD dye in ethanol solution. Figures 1; references 7: 1 Russian, 6 Western.

02415/06662

**Instability of Relativistic Electron Beam in Weak Longitudinal Magnetic Field**

18620193e Moscow FIZIKA PLAZMY in Russian Vol 13, No 4, Apr 87 pp 499-503

[Article by S.A. Komarov, V.D. Korolev, V.P. Smirnov, L.I. Urutskoyev, Institute of Atomic Energy imeni I.V. Kurchatov; manuscript received 27 Nov 87]

[Abstract] An experimental study of relativistic electron beams propagating through neutral gas under pressures of 10-100 torr was made, for a determination of the stabilizing effect of a longitudinal external magnetic field



on such an electron beam subject to instability caused by an otherwise fast buildup of transverse oscillations approaching the betatron wavelength. The experiment was performed in the NEPTUN facility, with electron beams characterized by a current of 10 kA, maximum electron energy of 450 keV, and pulse duration of 60 ns. A voltage pulse of 450 kV amplitude was applied across a diode, between a graphite-plate cathode 5 cm in diameter and a titanium-foil anode 20 gmm thick. The electron beam passed through the foil into a drift chamber containing nitrogen within glass walls, 1 m long and 20 cm in diameter. The magnetic field was produced by means of a solenoid, its intensity being variable over the 03- kOe range. Electrical measurements were made with a Faraday cylinder, while lateral plasma glow was recorded by high-speed photography with the aid of image converters. The experiment reveals that a longitudinal external magnetic field comparable in intensity with the intrinsic magnetic field of the electron beam facilitates transport of the electron beam in the form of a quasi-steady helix, with attendant establishment of two-dimensional equilibrium, while a much stronger longitudinal external magnetic field suppresses the resonance mode of resistive instability. The evidence is interpreted theoretically in terms of electron ballistics and applicable conservation laws. The authors thank S.V. Zakharov and S.F. Grigoryev for helpful discussions. Figures 7; references 4: all Russian.

02415/06662

**Stabilization of Dissipative Beam-Plasma Instability Attending Monoenergetic Relativistic Electron Beam 'Scattered' in Dense Plasma**  
18620193f Moscow *FIZIKA PLAZMY in Russian Vol 13, No 4, Apr 87 pp 506-508*

[Article by A.V. Baytin, M.G. Nikulin, A.b. Sionov, Moscow Institute of Radio Engineering, USSR Academy of Sciences; manuscript received 16 Dec 85]

[Abstract] A criterion of stabilization more rigorous than the increment of dissipative instability is established for a "weak" monoenergetic relativistic electron beam "scattered" in a dense plasma. It is based on the momentum and angle distribution function characterizing such an electron beam, with the momentum spread but not

the velocity spread of electrons ignored. On the basis of numerical evaluation for specific plasmas and electron beams, this criterion agrees closely with the solution to the corresponding dispersion equation. It reduces to a simpler form for self-focused electron beam with an inverse-quartic radial electron concentration profile. Figures 2; references 6: 3 Russian, 2 Western (1 in Russian translation).

02415/06662

**Acceleration of Charged Particles by Charge-density Waves Excited in Plasma by Laser Radiation and Relativistic Electron Beams**  
18620198 *FIZIKA PLAZMY in Russian Vol 13, No 5, May 87 pp 607-625*

[Article by Ya.B. Faynberg, Kharkov Institute of Engineering Physics, UkSSR Academy of Sciences; manuscript received 26 May 86]

[Abstract] Theoretical and experimental research done on acceleration of charged particles by Langmuir longitudinal charge-density waves in a plasma is systematically reviewed, for the purpose of comparatively evaluating excitation of such waves with laser radiation and with relativistic electron beams respectively. The review covers an analysis of fundamental relations describing the mechanisms and determining the characteristics of each process as well as crucial theories and experiments leading to latest achievements in this area. References 43: 15 Russian, 28 Western (3 in Russian translation).

02415/06662

**Superconducting Transition Temperature of Cu-Nb Microcomposites**

18620187d Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, Apr 87 pp 1203-1205

[Article by I.A. Kiyanskiy, T.I. Bryushkova, Yu.F. Bychkov, and A.Ya. Zhiltsov, Moscow Institute of Engineering Physics; manuscript received 19 Feb 86, in final version 18 Jun 86]

[Abstract] An experimental study of Cu-Nb microcomposites was made, its purpose being to determine the dependence of their superconducting transition temperature on the structure and the Nb content. Specimens with 20 percent Nb and with 40 percent Nb, four of each kind, were produced by mixing Cu powder of 5 gmm mean grain size and Nb powder of 40gmm mean grain size in the appropriate ratios, then compacting the mixtures and sintering them. Sintered compacts were drawn into wires 3.4-0.16 mm in diameter corresponding to 140-62,500 reductions. The superconducting transition temperature was determined accurately within 0.2 K by the induction method with a carbon thermometer which had been calibrated against a Ge resistance thermometer and critical temperatures of several metals and alloys as reference points. The readings are compared with those pertaining to Nb fibers 3.4-0.16 gmm in diameter extracted from wires of correspondingly 1000 times larger diameter. The coherence radius was determined on the basis of measurement of the electrical resistance of the Cu matrix at a temperature between 4.2 K and 50 K, which yielded 0.05 gmm at 4.2 K. The results indicate two critical temperatures with a characteristic resistivity "plateau" between them for specimens without residual resistivity and thus becoming perfect superconductors. They also indicate that the temperature range of superconducting transition becomes narrower with a higher Nb content, with the "plateau" eventually vanishing, evidently owing to a closer packing of Nb fibers. Figures 2; table 1; references 5: 1 Russian, 4 Western.

02415/0006

**Superconductivity and Crystal Structure of High-pressure Phases in Nb-Ru-H System**

18620187b Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, Apr 87 pp 1017-1025

[Article by V.Ye. Antonov, T.Ye. Antonova, I.T. Belash, Ye.G. Ponyatovskiy, and V.N. Rashchupkin, Institute of Solid-state Physics, USSR Academy of Sciences, Chernogolovka (Moscow Oblast; manuscript received 5 Sep 86)]

[Abstract] In an experimental study of four Nb-Ru alloys with 17, 25.5, 31, 50 atom.

Ru respectively was determined the pressure dependence of hydrogen solubility in them, was examined the crystal structure of the hydride phases forming upon hydrogenation of each alloy, and was determined the superconducting transition temperature of these phases. The alloys were made from 99.998pure Ru powder of 40 mesh size and zone refined Nb with a  $R_{300K}/R_{4.2K}/500$  resistance ratio in an induction furnace in an argon atmosphere. The ingots were annealed at a temperature of 1200SDC under a vacuum of the order of  $10^{-6}$  torr for 24 h and subsequently cooled in the furnace. Specimens were then cut from these ingots by the electric-spark process, whereupon a 0.05 mm thick surface layer was removed by grinding and another 0.03 mm thick layer was removed by electrolytic polishing in  $H_2SO_4$  solution so as to ensure perfection of the remaining 0.3 mm thick and  $3 \times 3$  mm<sup>2</sup> large final slices, measurements with a Link 860-500 energy-dispersion x-ray spectrometer of a "Camebax-MBX" microanalyzer indicating that the original chemical composition had been retained within  $\pm 0.4$  atom.. Hydrogenation was done with molecular  $H_2$  at a temperature of 325SDC under pressures up to 70 kbar for 24 h at each pressure level, with subsequent "quenching" under pressure to -180SDC.

The hydrogen content in specimens was determined accurately within  $\pm 5\%$  from the amount of hydrogen evolving upon thermal decomposition of hydrides at temperatures up to 500SDC. The hydrogen-to-metal atomic ratio was found to be highest,  $n = 1.92$ , in  $Nb_{83}Ru_{17}$  hydrogenated under pressures higher than 40 kbar. Structural examination and phase analysis of specimens after hydrogenation were done by the photometric method in a DRON-2.0 x-ray diffractometer with a  $CuK_{\alpha}$ -radiation source, at a temperature of 83 K so as to ensure retention of hydrogen and phase composition for 16-48 h, the structure of all specimens having been found to be polycrystalline, pure  $Nb_{83}Ru_{25.5}-H$  and  $Nb_{69}Ru_{31}-H$  are most reliable and indicate a  $\gamma$ -phase with an f.c. tetragonal lattice, its superconducting transition temperature being 5.08 K and 4.3 K respectively, a nonsuperconducting  $gy$ -phase with a c.p. hexagonal lattice under top pressures, and the  $ga$ -phase. The data on  $Nb_{50}Ru_{50}-H$  indicate nonsuperconducting  $\gamma_1$ -phase under up to 10 kbar and  $\gamma_2$ -phase under up to 20 kbar with most likely an f.c. rhombic lattice each, then  $gy'$ -phase with a rhombically distorted c.p. hexagonal lattice under higher pressures. The data on  $Nb_{83}Ru_{17}-H$  indicate nonsuperconducting  $gy$ -phase under 12-35 kbar and  $gq'$ -phase under 40-70 kbar. Figures 5; tables 1; references 16: 7 Russian, 9 Western.

02415/06662

**Electron-Nuclear Double Resonance of  $Er^{3+}$  Ions in Perovskite-type Crystals**

18620181c Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 4, May 87 pp 1546-1550

[Article by M.M. Zaripov, I.R. Ibragimov, and M.L. Falin, Kazan Institute of Engineering Physics, USSR Academy of Sciences, Kazan branch; manuscript received 15 Sep 86, in final version 18 Nov 86]

[Abstract] An experimental study of hyperfine interaction of rare-earth ions, specifically the tetragonal  $\text{Er}^{3+}$  ion, and ligand ions in a  $\text{KMgF}_3$  crystal was made by the method of electron-nuclear double resonance. The crystals had been grown by the Czochralski method in a helium atmosphere, with a 6

Er admixture. Measurement of electron-paramagnetic resonance and of electron-nuclear double resonance in the (001) plane were made with two 3-cm spectrometers, an ERS 231 (GDR) and an RE 1302 (USSR) respectively, at a temperature of 4 K. The data are evaluated in terms of the spin-Hamiltonian, which involves diagonalization of the one-particle nuclear Hamiltonian after averaging over the electron variables in the second-order approximation theory of perturbations and subsequent application of the sampling rule to ENDR transitions. The results yield a structure of the  $[\text{ErF}_6]^{3-}$  complex characterized by  $C_4$ -symmetry and absence of central symmetry. They reveal that the  $\text{Er}^{3+}$  ion replaces the  $\text{Mg}^{2+}$  ion with local compensation occurring as a non-magnetic ion replaces one of the F ions in the nearest surrounding. The parameters of this structure have been calculated from the angular distribution of ENDR lines in the (001) plane. With noncubic rare-earth ions in the crystal, there had thus been discovered a multiplet structure of ENDR lines from  $F_{1,4}$  ions. This structure is produced by indirect interaction of ligands through a paramagnetic center, the lines from  $F_{1,3}$  retaining such a structure through angles  $\approx 90^\circ$ -SSDC before it becomes transformed at angles smaller than SSDC owing to the presence of  $F_{2,4}$  ions. The authors thank M.M. Yeregin for helpful discussions and V.A. Ulanov for supplying crystal specimens. Figures 2; tables 2; references 8: 1 Russian, 1 Hungarian, 6 Western.

02415/06662

**Thermal Model Describing Development of Normal Region in Superconductor Film Carrying Electric Current**

18620182a Leningrad ZHURNAL TEKHNIЧЕСКОЙ ФИЗИКИ in Russian Vol 57, No 4, Apr 87 pp 663-668

[Article by O.G. Vendik, O.V. Pakhomov, and L.L. Tereshcheko, Leningrad Institute of Electrical Engineering imeni V.I. Ulyanov (Lenin); manuscript received 11 Feb 86]

[Abstract] Development of a normal region by laser radiation in a superconductor film carrying electric current is analyzed on the basis of experimental data and a mathematical model. For the experiment, 0.1 gmm thick Nb films with the superconducting transition temperature range  $7.6 \pm 0.1$  K were deposited on 0.5 mm thick leucosapphire substrates by the electron-beam vacuum-evaporation process. An active strip in the form of a bridge with a 10 gmm wide and 100 gmm long microconstriction was produced in such a film by the photolithographic process. An infrared light-emitting semiconductor laser diode ( $\lambda = 0.85$  gmm wavelength) with

bilateral heterostructure served as continuous-wave radiation source with power regulation. The light was transmitted to a superconductor film through a 1 m long optical fiber 50 gmm in diameter with a near-Gaussian power density distribution over the cross-section along the entire fiber. The current-voltage characteristics of microconstrictions was measured at the 4.2 K temperature in liquid helium, with the laser power varied from 0 to 15 mW and the current in pulses of 1-10 gms duration with a repetition rate of 10 kHz from a GS-15 generator varied through the superconducting range. Transition to normal state occurred at a current ranging from 100 mA without irradiation down to zero at some critical radiation power, recovery of the superconducting state occurring at a current of 14.3 mA in the absence of radiation. The dependence of the velocity of the two S-N transition fronts propagating along a microconstriction on the electric current through the latter and on the power of impinging radiation is interpreted theoretically on this basis of a thermal model, a system of three analogous differential equations of heat conduction for the three successive regions with appropriate boundary conditions, with the N region symmetrically at the center and heat flowing from it downward through the substrate to a heat sink. For a quantitative evaluation of this thermal S-N transition mechanism, the thermophysical parameters of an  $\text{Nb-Al}_2\text{O}_3$  structure are calculated on the basis of experimental data and in accordance with superconducting transition theory. These parameters are thermal conductivity of the film-substrate junction, heat spreading distance and effective thermal conductivity along the film, and effective coefficient of thermal diffusion. Figures 5; references 8: 3 Russian, 5 Western (2 in Russian translation).

02415/06662

**Critical Magnetic Field Intensities for Gamma-(BEDT-TTF) $_2$ I $_3$  in High-temperature Superconducting Phase**

18620200a Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian Vol 45, No 7, 10 Apr 87 pp 355-357

[Article by L.N. Bulayevskiy, V.B. Ginodman, and A.V. Gudenko, Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences; manuscript received 2 Mar 87]

[Abstract] An experimental study of (BEDT-TTF) $_2$ I $_3$  in the high-temperature gb-H phase (transition temperature  $T_c = 7.8$ -8.0 K) was made, for the purpose of determining its critical magnetic field intensities, this metastable phase having been produced by application of a low hydrostatic pressure not exceeding 500 bar to crystals of the low-temperature gb-L superconducting phase (transition temperature  $T_c = 1.3$ -1.5 K) with subsequent pressure reduction to normal level at a temperature of 90-100 K with maintenance of crystals in the metastable state. Measurement of the electrical resistance in a magnetic field of variable intensity and oriented parallel



to either the c-axis to the b-axis of a crystal has yielded the temperature dependence of the second critical magnetic field intensity  $H_{c2}$  as well as of its anisotropy, also of the parameter  $H_{c2}(T)/T_c dH_{c2}/dT$  with the temperature normalized to the transition temperature  $T_c$  for both phases. The results agree closely with theoretical predictions and indicate that the gb-L phase conforms to the Bardeen-Cooper-Schrieffer model. The authors thank E.b. Yakubovskiy, I.F. Shchegolev, and V.N. Laukhin for supplying the specimens and discussing the results, also L.N. Zherikhina for assistance and participation. Figures 3; references 11: 6 Russian, 5 Western.

02415/06662

**Vibration Spectrum and Dynamics of  $\text{Li}_2\text{Ge}_2\text{O}_7$  Crystal Lattice**

18620192b Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 4, Apr 87 pp 793-795

[Article by V.N. Sharaychuk, V.N. Moiseyenko, and M.D. Volnyanskiy; manuscript received 11 Nov 85]

[Abstract] An experimental study of  $\text{Li}_2\text{Ge}_2\text{O}_7$  single crystals was made, for the purpose of determining the complete lattice vibration spectra in the para-phase as well as in the ferroelectric phase. Specimens of high optical grade, grown by the Czochralski method into parallelepipeds of the  $D^{14}_{2h}$  space group, contained  $7.42^6\text{Li}$  isotope. Raman scattering of light was induced by radiation at the  $\lambda = 488$  nm wavelength from an ILA-120 laser with 1 W power rating and was analyzed with a DFS-12 spectrometer, gaps in the spectra being  $2\text{ cm}^{-1}$  wide, after it had been recorded in the slow mode by photon count with storage. The polarization geometry of scattering in the para-phase at a temperature of 300 K was varied, that in the ferroelectric phase at a temperature of 273 K. The results reveal three spectral ranges of lattice vibrations in the para-phase: 1) external vibrations including translational and librational ones of  $\text{T}_{\text{GeO}_4}$ ,  $\text{R}_{\text{GeO}_4}$  tetrahedra and  $\text{T}_{\text{GeO}_6}$ ,  $\text{R}_{\text{GeO}_6}$  octahedra within the  $30\text{--}170\text{ cm}^{-1}$  range, 2) deformation vibrations  $\text{O}_{\text{Ge-O}}$  within the  $190\text{--}690\text{ cm}^{-1}$  range, 3) valence vibrations  $\text{Ge-O-Ge}$ ,  $\text{O-Ge-O}$  within the  $650\text{--}1150\text{ cm}^{-1}$  range. These spectra of Raman scattering are found to be denser than those of a  $\text{Li}_2\text{GeO}_3$  crystal lattice, especially in the low-frequency range, with valence and deformation vibrations occurring within the same respective frequency ranges. Figures 1; tables 1; references 7: all Western.

02415/06662

**Optical Nonlinearity Attending Resonant Formation of Strongly Couple Excitons**

18620192c Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 4, Apr 87 pp 796-800

[Article by Kh.V. Nerkararyan; manuscript received 5 May 86]

[Abstract] Optical nonlinearity in crystals within the exciton range of the spectrum is analyzed, including dependence of the resonance frequency on the exciton

concentration and of that nonlinearity on the interexciton interaction as well as the role of the correlation effect in strong interaction with a correspondingly short-range potential. A one-dimensional crystal in the form of a closed chain of periodically spaced-like atoms is considered and its behavior with excitons in the fields of a strong electromagnetic wave is determined on the basis of the corresponding Hamiltonian. When the exciton radius is smaller than half the lattice constant, then there is no possibility of two simultaneous excitations in any one lattice node. When the exciton radius is larger than half the lattice constant, then nonresonant processes are ignored here while energy unbalance precludes resonant excitation transfer to an atom whose neighbor is excited so that there remains only the possibility of resonant excitation of an atom whose neighbor is not excited. Calculations involving a unitary transformation and finding the wave function for the ground state by the variation method with use of an undetermined Lagrange multiplier reveal the possibility of amplitude and frequency hysteresis in the case of a large matrix element representing excitation transfer and a corresponding wide exciton band. References 7: 5 Russian, 2 Western.

02415/06662

**Giant Josephson Signal in Wide Superconducting Films**

18620197c PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 45, No 10,  
25 May 87 pp 483-486

[Article by Yu.M. Ivanchenko, P.N. Mikheyenko, and Ya.I. Yuzhelevskiy, Donetsk Institute of Engineering Physics, UkSSR Academy of Sciences; manuscript received 1 Apr 87]

[Abstract] Synchronous movement of multiquantum magnetic flux tubes appearing in thin current-carrying films of type-II superconductors such as In according to Josephson's law is proposed to be the mechanism of giant-signal generation. This theory is based on an experiment which has revealed oscillations in such films with the second critical magnetic field intensity more than two orders of magnitude higher than that for thick In layers. The experiment was performed on microbridges with nonuniform thickness and on microbridges with constriction, their length and width respectively about equal to and much larger than the  $10^{-2}\text{ cm}$  characteristic thermal distance defined as width of the band with a temperature gradient. Measurement of the current-voltage characteristics has revealed a sharp transition from a steep first drooping to a less steep second drooping range with giant oscillations which cease as the voltage reaches the  $2TgD/e=0.5\text{ mV}$  levels ( $T$ -temperature in flux-crowding region,  $gD$ -order parameter,  $e$ -electron charge). According to this model, the velocity of the magnetic flux tubes does not depend on the frequency of those oscillations and the maximum frequency of the latter is limited by the distance between magnetic flux

tubes, which cannot be larger than the characteristic thermal distance, so that the ratio of maximum frequency to minimum frequency is equal to the ratio of microbridge width to characteristic thermal distance. Figures 3; references 4; 2 Russian, 2 Western.

02415/06662

### Organic Metal $(\text{ET})_4\text{Hg}_3\text{Br}_8 \cdot \text{A}$

#### Quasi-two-dimensional Superconductor

18620183c Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 45, No 9, 10 May 87 pp 416-418

[Article by R.N. Lyubovskaya, Ye.A. Zhilyayeva, A.V. Zvarykina, V.N. Laukhin, R.B. Lyubovskiy, and S.I. Pesotsky; manuscript received 12 Mar 87]

[Abstract] The first salt of bis-(ethylene dithiotetrathiafulvalene) with the  $[\text{Hg}_3\text{Br}_8]^{2-}$  exchange anion, upon transition into the superconducting state, has been found to be a quasi-two-dimensional superconductor. It has also been found to exist in at least three phases: a dielectric one already at room temperature, a dielectric one below 180K, and an  $(\text{ET})_4\text{Hg}_3\text{Br}_8$  phase still metallic at temperatures near zero. This metallic phase is a crystalline one with a rhombic lattice typically 0.-0.5 mm thick and 0.5-2 mm wide along the diagonals. Direct resistance measurements at a temperature of 300 K have yielded a longitudinal electrical resistivity of 150-300 ohm.cm and a transverse electrical resistivity of 0.2-2 ohm.cm, this anisotropy increasing further with a lowering of the temperature. Wide temperature ranges of the transitions and soft bends of the resistance-temperature curves indicate a nonhomogeneity of  $(\text{ET})_4\text{Hg}_3\text{Br}_8$  specimens owing to existence of either two different superconducting phases or regions with large internal stresses. Existence of two superconducting phases corroborated by the trend of superconductivity suppression by a transverse magnetic field, the resistance ( $R_1$ )-field( $H_1$ ) curve having one bend within the 4.2-3 K temperature range and two bends at higher temperatures. Assuming that a bend corresponds to the upper critical magnetic field intensity for superconducting transition, its temperature dependence has been calculated for both superconducting transitions.

The authors thank I.F. Shchegolev for interest and support, L.O. Atovmyan, O.A. Dyachenko, and T.G. Takhirov for supplying structural data prior to their publication, O.Ya. Neyland and V. Yu. Khodarkovskiy for supplying the raw donor material. Figures 3; reference 9: 3 Russian, 6 Western. 02415/06662

### Resorption of Excess Phonons in Superconducting Microjunctions

18620183d Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Nov 45, No 9,  
10 May 87 pp 425-428

[Article by I.K. Yanson, V.V. Pisun, N.L. Bobrov, and L.F. Rybalchenko, Institute of Low-Temperature Engineering Physics, UkSSR Academy of Sciences; manuscript received 31 Mar 87]

[Abstract] Varying the electrical resistance of Ta-Cu and Ta-Au heterojunctions in an experiment made it possible to track a smooth transition from nearly normal to anomalous microjunction S-c-N energy spectra. In the spectra of wide microjunctions it revealed singularities at energy levels corresponding to phonons with near zero group velocity and thus slowly leaving the junction region with an attendant local narrowing of the energy gap. These phonon singularities are caused by inelastic Andreyev reflection of electrons in the immediate vicinity of the S-N boundary. An analysis of the phonon peaks and their deformation as a junction resistance decreases, with the width of the junction ceasing to be much smaller than the electron energy relaxation distance as in the case of a low-resistance of "dirty" junction, indicates a diffusion process and a resorption of excess phonons but with a spectrum of the superconducting state which differs increasingly from the theoretically predicted one as their resorption in the normal state increases and with it the noise component of the spectrum. Figures 3; references 8: 6 Russian, Western.

02415/06662

### Properties of Superconductors With Strong Electron-Phonon Interaction

18620183b Moscow PISMA V ZHURNAL  
EKSPERIMENTALNOY I TEORETICHESKOY  
FIZIKI in Russian Vol 45, No 9, 10 May 87 pp 413-415

[Article by L.N. Bulayevskiy and O.V. Dolgov, Institute of Physics imeni P.N. Lebedev, USSR Academy of Sciences; manuscript received 11 Mar 87]

[Abstract] The properties of superconducting materials anomalously departing from the Bardeen-Cooper-Schrieffer model, namely of  $\text{Ba}(\text{Pb}_{1-x}\text{Bi}_x)\text{O}_3$  compounds and various organic compounds such as  $\text{gb}_\text{H}-(\text{BEDT-TTF})_2\text{I}_3$  or  $\text{gb}-(\text{BEDT-TTF})\text{AuI}_2$ , are calculated on the basis of the Eliashberg model with a single phonon mode and a large coupling coefficient  $g|1|$  characterizing strong electron-phonon interaction. The superconducting transition temperatures and the upper critical magnetic field intensity are accordingly calculated from the corresponding equations of this model as functions of this coupling coefficient, with only the orbital field effect considered and with Coulomb repulsion ignored. In addition the temperature dependence of the upper critical magnetic field intensity is also determined. From the

Ginzburg-Landau free-energy functional for the case of a uniform order parameter the dependence of the electron states density at near zero temperature on the jump of specific heat, on both upper and lower critical magnetic field intensities, and on the residual electrical resistivity of a "dirty" superconductor is then obtained. The

authors thank M.O. Ptitsyn for performing numerical computations. Figures 1; references 10: 2 Russian, 8 Western.

02415/06662



**Rotation of Universe**

18620194a Tomsk IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: FIZIKI in Russian Vol  
30, No 3, Mar 86 pp 12-16

[Article by D.d. Ivanenko and V.g. Krechet, Yaroslavl  
Pedagogical Institute; manuscript received 28 Nov 84]

[Abstract] Rotation of the Universe is considered, this possibility being indicated by the anisotropy of radio emission by many cosmic sources. In accordance with the concept of a hierarchically structured physical reality and by methods of the General Theory of Relativity for gravitation, analytical expressions are derived for the angular momentum of the three principal objects in this hierarchy: maximon - hadron- Metagalaxy. Formal description of the geometrical configuration of current

lines of a continuous medium in the Einstein-Cartan space leads to the Raychauduri equation in the Riemannian space and to twist of the space-time continuum in the form of a pseudotrace as the likely cause of rotation, the cosmological model with twist being the source of rotation in the Godel model. Extension of the stationary metric to a nonstationary space with rotation and with twist yields a relation of the Regge kind for the spin of a Metagalaxy which also applies to elementary particles. Further calculations are therefore made using the ratio of Universe mass to proton mass and the Dirac concept of "large numbers," as well as estimates according to Markov, Recami, Salam, and Stanyukovich. The authors thank V.F. Panov for discussion and valuable comments. References 14; 7 Russian, 7 Western.

02415/06662

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